

THE HELMET SHELLS OF THE WORLD (CASSIDAE). PART 1.

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The family Cassidae is a world-wide tropical and temperate seas group of caenogastropods, popularly known as helmet or bonnet shells, which is closely related to the families Bursidae, Cymatiidae and Tonnidae. It is placed by Thiele

(1929) and Wenz (1941) in the superfamily Tonnaea. The family originated in the Lower Eocene, and by the Miocene had become established throughout the warm and temperate seas of the world. Today there are about 60 living species, most of which occur in waters from the low tide mark to a depth of about 100 meters. The deepest record is 1,100 meters off East Africa.



Plate 1. Female *Phalium* (*Semicassis*) *granulatum* (Born, 1778) of Florida in the process of building a tower-shaped egg mass. Each brown, horny capsule is extruded from a pore

in the sole of the foot and put in place by the edge of the foot. Each capsule contains several dozen eggs. Photographed at the Marine Studios, Marineland, St. Augustine, Florida.

In part 1, the genera treated are *Cassis*, *Phalium*, *Casmaria*, and *Cypraccassis*. Part 2 will include *Sconsia*, *Dalium*, *Morum*, *Galeodea*, *Morionella* and *Taieria*. About 1,100 specific and varietal names have been applied to Recent and fossil cassids.

Adult cassid shells range in size from 1 to 15 inches and are usually characterized by an ovate shape, a large body whorl, one or more varices, a well-developed parietal or columellar shield, and by a small, bulimoid, shelly nucleus. The operculum, present in most adults, is corneous, thin, semi-circular or fan-shaped, and brown. The radula is taenioglossate, with about 80 to 220 rows of teeth, with each row bearing seven rather delicate, minutely-cusped teeth. The pleurembolic proboscis is retracted within the head when not in use. The eyes are at the base of the moderately long, thin tentacles. Males have a long, prong-like penis attached to the right side of the head. The sperm travels to the top of the penis along an open groove. Females (in *Phalium*) lay eggs within small capsules which are built into tower-like structures. The capsules are formed by a round sphincter in the sole of the foot. *Galeodea*, from the Mediterranean, lays 300 eggs in each capsule, but only 4 to 12 develop fully, the remainder serving as food or "nurse cells" for the others (Erlanger, 1893).

The length of the free-swimming larval stage is unknown, but the presence of four or five whorls in the nucleus suggests that it may be up to several weeks.

A slight degree of sexual dimorphism in the shell is evident in *Cassis cornuta* (Linné), males having fewer and longer knobs on the shoulder.

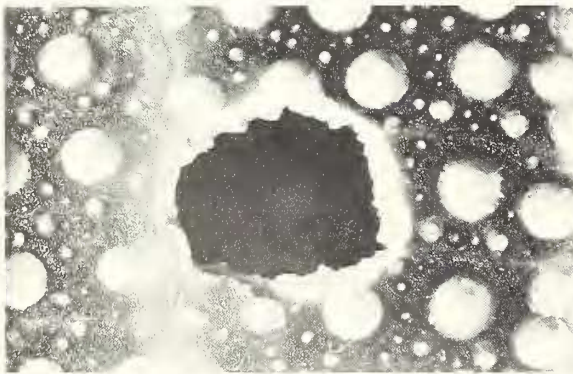


Plate 2. Hole (5.5 mm. in diameter) in the denuded test of the sea urchin, *Lytechinus variegatus* (Lamarck) made by *Cassis tuberosa* (Linné) in an aquarium in the Bahamas. (courtesy of Robert Robertson).

Males of *Phalium* usually are much smaller than the females.

The food of *Cassis* and *Phalium* consists of various echinoderms such as sea urchins, sand dollars and sea biscuits belonging to the class Echinoidea (R. E. Schroeder, 1962; R. W. Foster, 1947; F. B. Lyman, 1937; D. R. Moore, 1956; and I. Cornman, 1963). In attacking a long-spined sea urchin, such as *Diadema antillarum*, a *Cassis* everts its proboscis and waves the tip over the surface of the urchin's test, at the same time squirting out an acidic salivary fluid which immobilizes the spines. The active principle of the saliva would appear to be a neurotoxin with paralyzing properties (I. Cornman, 1963). Cassids may crush or bore through the test of the urchin.

Cassis madagascariensis and *tuberosa* of the Caribbean region feed upon the long-spined sea-urchin, *Diadema antillarum* Philippi. According to Schroeder (1962, Sea Frontiers, vol. 8, no. 3, pp. 156-160), when these gastropods encounter an urchin on which they wish to feed, they elevate the foot anteriorly, creep forward, and fall upon the prey, pinning it beneath. Within about 10 minutes the proboscis rasps a hole in the test of the urchin about 6 to 10 mm. in diameter for feeding. The helmet shells may remain on top of the urchin for an hour or more. Surprisingly, the spines rarely penetrate the foot of the snail.

The geographical distribution of *Cassis tuberosa* (Linné) overlaps that of the sea urchin, *Lytechinus variegatus* (Lamarck), upon which it feeds (Bermuda and North Carolina, south through the Caribbean to Brazil). *Cassis madagascariensis* Lamarck and one of its foods, *Diadema antillarum*, have a common but more restricted range (Bermuda and North Carolina to the southern Caribbean).

Dr. Robert Robertson has kindly allowed me to quote from his unpublished notes the following remarks on the behavior of *Cassis* in the Bahamas.

"Species of *Cassis* are usually rather deeply buried in sand at Bimini so that occasionally only a small portion of a shell projects. Sometimes *Cassis* occurs in *Thalassia* beds. All species in the genus *Cassis* probably feed exclusively on echinoids. The thick skin on the foot is an adaptation which facilitates capture without injury from the spines. *C. tuberosa* and *C. madagascariensis* are most frequently found eating the sea biscuit *Clypeaster rosaceus*, show-

ing preference for small individuals. All three species of *Cassis* will, however, readily also attack sea urchins in a large aquarium but at night only. While feeding, the foot of the *Cassis* partially surrounds the echinoid (which often is held deep in the sand) and copious mucus is produced. Some or all of the spines of the echinoid are removed and the proboscis of the *Cassis* is either inserted through the anus, as has been observed at Bimini by Foster (1947) in the case of a *C. tuberosa* feeding on *Clypeaster*, or through a hole which is made in the test. The test of *Clypeaster* usually breaks apart while *Cassis* feeds. *Cassis* feces consist chiefly of the spines of the echinoids which have been fed upon; the spines are enclosed in a mucous covering.

The holes through sea urchin tests made by *Cassis* at Bimini are more or less circular and from 4 to 6 mm. in diameter. There seems to be no special area on the test which is pierced. An acid appears to be used, at least in part, to make the hole, for the edge is smoothly rounded and concave all around except at each joint between plates of the test where there is either an irregular groove or a lamina."

The family has a limited economic value. For many centuries, shell cameos have been carved from Indian Ocean *Cypræocassis rufa* (Linné). During the 19th century *Cassis madagascariensis* Lamarck and *tuberosa* (Linné) of the West Indies were used to a lesser extent. The meat of larger species is eaten in many parts of the world. E. R. Cross (1967) gives an excellent recipe for chowder made from the minced foot and columellar muscle of *Cassis cornuta* (Linné).

Distribution of Cassids

The world-wide family of Cassidae contains about 60 living species. About one fourth of these possess subspecies. In the tropical Indo-Pacific there are 20 living species and subspecies (exclusive of *Galeodea*, *Morum* and *Sconsia*), while in the Caribbean there are only seven.

Although the cassids are predominantly a warm-water group, they have a somewhat different distribution than that of the family Strombidae, which contains about the same number of species (see Indo-Pacific Mollusca, vol. 1, no. 2, p. 09-838, pl. 19). The cassids have a wider distribution, with about ten percent of the species living in the cool waters of the

southern hemisphere and five percent living in northern temperate regions. This ability to survive colder waters is demonstrated by the bathymetric range of several cassids which may live at depths from 100 to 1,100 meters. This is in contrast to the herbivorous Strombidae which do not live below 100 meters.

The concentration of species in the center of the Indo-Pacific, along the Western Pacific Arc, is much less pronounced in the cassids, although that area has the highest number of cassid species. As would be expected, there is a gradual diminishing in the number of species towards the east where there are only a few species in Polynesia. There are no cassids endemic to the Western Pacific Arc, although *Phalium bandatnm* and *Phalium decussatum* live in approximately that area.

There are several shallow-water species of cassids with rather restricted ranges—*Phalium umbilicatum*, from the Hawaiian Chain; *Phalium strigatum*, from China, Korea and Japan; *Phalium bandatnm* subspecies *exaratum*, from the Mauritius-Seychelles area; and *Phalium faurotis*, from the western edges of the Indian Ocean. The distribution of the latter is similar to that of *Strombus fusiformis*.

Six cassid species are widely distributed over most of the Indo-Pacific, from the Red Sea to Polynesia. In size of adults, these range from the small, inch-long *Casmaria ponderosa* to the large, foot-long *Cassis cornuta*. There was no correlation between the size of the nuclear whorls, which is sometimes indicative of the length of the free-swimming larval stage, and the extent of the geographical distribution.

The relative abundance of individuals over the entire range of the species may vary considerably. This is not always because of the lack of or presence of suitable habitats. It may be a case of the species dying out for any one of a number of biological reasons, or that it is a new arrival to the area. One notable case is *Cypræocassis rufa*, a large, conspicuous, shallow-water species. In central East Africa it is so abundant that it is fished commercially in large numbers. In the central Indian Ocean it is moderately common. However, farther to the east, in the Philippines and East Indies, it is fairly rare, and only isolated, small colonies are encountered in Melanesia. Its occurrence is very sparse in Micronesia. In the Line Islands and other easterly Polynesian archipelagos, the species becomes increasingly abundant. Pos-



Plate 3

- Figs. 1-4. *Cassis cornuta* (Linné, 1758). 1 and 2, young from Cebu Id., Philippines; 3, adult from Luzon Id., Philippines; 4, adult male from Babelthup, Palau Ids.
 5, 6. *Cassis tessellata* (Gmelin, 1791). Gaboon, West Africa.

- 7, 8. *Cassis flammea* (Linné, 1758). Bahama Islands.
 9. *Cassis madagascariensis* Lamarek, 1822. New Providence Id., Bahamas.
 10. Cameo carved in Italy from *Cypraea rufa* (Linné, 1758) from East Africa.
 11. *Cassis tuberosa* (Linné, 1758). Cabo Rojo, Puerto Rico.

(all 1/3 natural size; shell in fig. 3 is 7 inches in length)



Plate 4

- Figs. 1-4. *Cassis fimbriata* Quoy and Gaimard, 1833. 1, Eucla, Western Australia. 2, form resembling type of *bicarinata* Jonas, South Australia. 3 and 4, young and adult from Gulf of St. Vincent, South Australia. 5, 6. *Cassis nana* Tenison-Woods, 1879. Adults from off Tin Can Bay, Queensland, Australia. 7. *Cypraea tenuis* (Wood, 1828). Gulf of California.

8. *Cypraea coarctata* (Sowerby, 1825). Pedro Gonzales, Perlas Ids., Panama. 9. *Cypraea testiculus* (Linnaeus, 1758). Dominica, Lesser Antilles. 10-12. *Cypraea rufa* (Linnaeus, 1758). 10, immature, Mkunduchi, Zanzibar. 11, adult, Mozambique City. 12, dwarf adult, Peros Banhos Id., Chagos Islands.

(all 1/2 natural size)

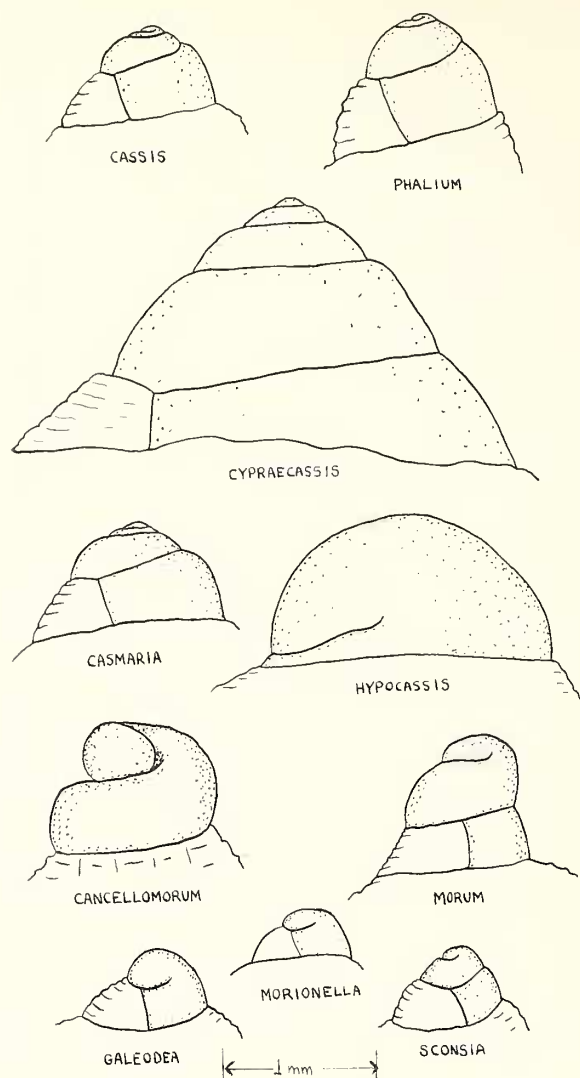
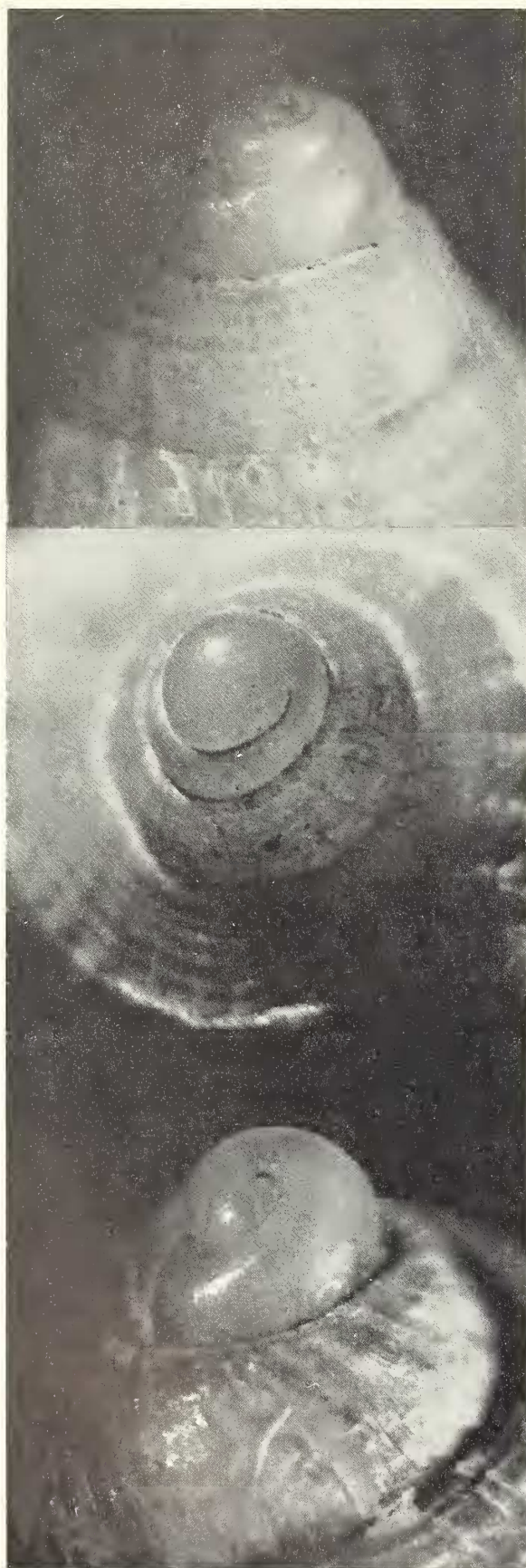


Plate 6. Nuclear whorls of various genera of Cassidae. All enlarged proportionately. Examples are from *Cassis cornuta* (Linné) from Hawaii; *Phalium glaucum* (Linné) from Phuket, Thailand; *Cypraecassis rufa* (Linné) from Zanzibar; *Casmaria erinaceus* (Linné) from Samar Island, Philippines; *Cassis (Hypocassis) fimbriata* Quoy and Gaimard from South Australia; *Cancelloporum* (Emerson and Old, 1963) *cancellatum* (Sowerby) from Japan; *Morum oniscus* (Linné) from Nassau, Bahamas; *Morionella cancellata* (Lamarck) from the Eocene of France; *Galeodea echinophora* (Linné) from Sicily, Italy; and *Sconsia striata* (Lamarck) from off Yucatan, N.E. Mexico.



Plate 5. Greatly enlarged nuclear whorls of (top), *Phalium glaucum* (Linné) (0.7 mm. in diameter); (center), *Cassis (Hypocassis) nana* Tenison-Woods (1 mm. in diameter); (bottom), *Galeodea echinophora* (Linné) (0.5 mm. in diameter). Photos courtesy of Al Jehle.

sibly this species is dying out in the central areas of its range.

Far to the east, this species is replaced by the quite similar *Cypraecassis tenuis*, which ranges from Baja California and Clipperton to the Galapagos Islands. I suspect that this Eastern Pacific species has descended from formerly wide-spread colonies of the Indo-Pacific *rufa* which perhaps extended to the Eastern Pacific during late Pliocene or early Pleistocene times.

A rather curious, and related, type of distribution exists in the very widely distributed *Casmaria erinaceus*, which extends from Africa to Central America. I have carefully examined all known specimens from the Eastern Pacific, and conclude that they are barely distinguishable from Indian Ocean and East Indian specimens. Yet, between these areas is the intervening and quite distinct subspecies *kalosmodix*, extending from Hawaii in the north to Tonga and Pitcairn in the south. I question that the Eastern Pacific colonies are recent arrivals coming in as free-swimming, long-lived larvae, since the three warm-water currents flowing from the central Pacific (the North Equatorial Counter Current, the Equatorial Undercurrent and the South Equatorial Counter Current) pass through about 2,000 miles of *kalosmodix* territory in Polynesia. Under the circumstances, one would expect the Galapagos and Central American forms to be *kalosmodix*, rather than the East Indian form. It is more reasonable to conjecture that the Eastern Pacific colonies represent residue populations from some former epoch when the distribution of *erinaceus* extended across the entire Indo-Pacific. The subspecies *kalosmodix* is probably a recent development which has either replaced the typical form by competition or filled in the vacancy resulting from the dying out of the typical form by disease or Pleistocene cold periods.

The distribution of cassids, especially in the Indo-Pacific, is rather similar to that of the tropical echinoids (see E. Mayr, 1954, *Evolution*, vol. 8, pp. 1-18) and of the *Myripristis* squirrelfish (see D. W. Greenfield, 1968, *Systematic Zoology*, vol. 17, no. 1, pp. 76-87). The latter underestimates the relatively recent invasion of western Pacific elements into the Indian Ocean in the areas of Cocos-Keeling and the Nicobar Islands (see V. O. Maes, 1967, *Proc. Acad. Nat. Sci. Philadelphia*, vol. 119, pp. 93-217).

Continental and Oceanic Species

A large proportion of the shallow-water Indo-Pacific cassids fall into one or the other of these two general ecologic groups:

1. Species limited to the rich nitrogenous shores of continents or well-vegetated, "high", volcanic islands.

(<i>Phalium</i>)	(<i>Semicassis</i>)
<i>glaucum</i>	<i>bisulcatum</i>
<i>decussatum</i>	<i>faurotis</i>
<i>bandatum</i>	(<i>Xenophalium</i>)
<i>strigatum</i>	<i>pyrum</i>

2. Species mainly living in clear, oceanic waters surrounding small coral islands, submerged banks or in similar oceanic conditions bordering large islands and continents.

(<i>Cassis</i>)	(<i>Casmaria</i>)
<i>cornuta</i>	<i>erinaceus</i>
(<i>Cypraecassis</i>)	<i>pouderosa</i>
<i>rufa</i>	

Hybridization

It is likely that interspecific hybrids occur among cassid species. Hybrids between supposedly different species have been experimentally produced in land, fresh-water and marine species. Boss (1964, *Nautilus*, vol. 78, no. 1, pp. 18-21) records a probable cross in nature of *Tellina magna* and *T. laevigata*, and cites other hybrid records in the literature. Powell (1928, *Trans. and Proc. New Zealand Inst.*, vol. 59, pt. 3, p. 633) records possible natural hybrids between "*Xenophalium labiatum* and *X. insperatum*", and also between subspecies of the buccinid *Verconella adusta*.

Most of these hybrids, including those from the *Cerion* experiments of Bartsch (1925) and the *Viviparus* crossings of V. Franz (1928) are open to question, since there is no evidence that actually different species were involved. In other records of supposed hybrids, such as between *Cypraea eburnea* and *C. miliaris* (R. J. Griffiths, 1960, *The Cowry*, vol. 1, no. 6, p. 94) the true relationship of the parent stocks is uncertain and may be cases of single color gene or subspecific differences.

Powell attempted to substantiate hybridization between the supposedly different cassids, "*Xenophalium labiatum* and *X. insperatum*" by citing



Plate 7

Figs. 1,2. *Phalium fimbria* (Gmelin, 1791). Ceylon.

3,4. *Phalium strigatum* (Gmelin, 1791). Eastern Asia.

5-7. *Phalium arcola* (Linné, 1758). 5 and 7, Queensland, Australia. 6, dark form from Tabaco Bay, Luzon Id., Philippines.

8,9. *Phalium decussatum* (Linné, 1758). Formosa.

10-12. *Phalium glaucum* (Linné, 1758). 10 and 11, young and adult from Mariveles, Luzon Id., Philippines. 12, adult from Bougainville Id., British Solomon Islands.

13. *Phalium arcola* forma *agnitum* Iredale. (young *arcola*). Broome, Western Australia.

14-16. *Phalium bandatum bandatum* (Perry, 1811). 14, off Darwin, Northern Territory, Australia. 15, Olango Id., Cebu Id., Philippines. 16, young from off Cape Ford, Northern Territory, Australia.

17. *Phalium bandatum* subspecies *exaratum* (Reeve, 1848). Seychelles Islands.

(all 1/2 natural size)

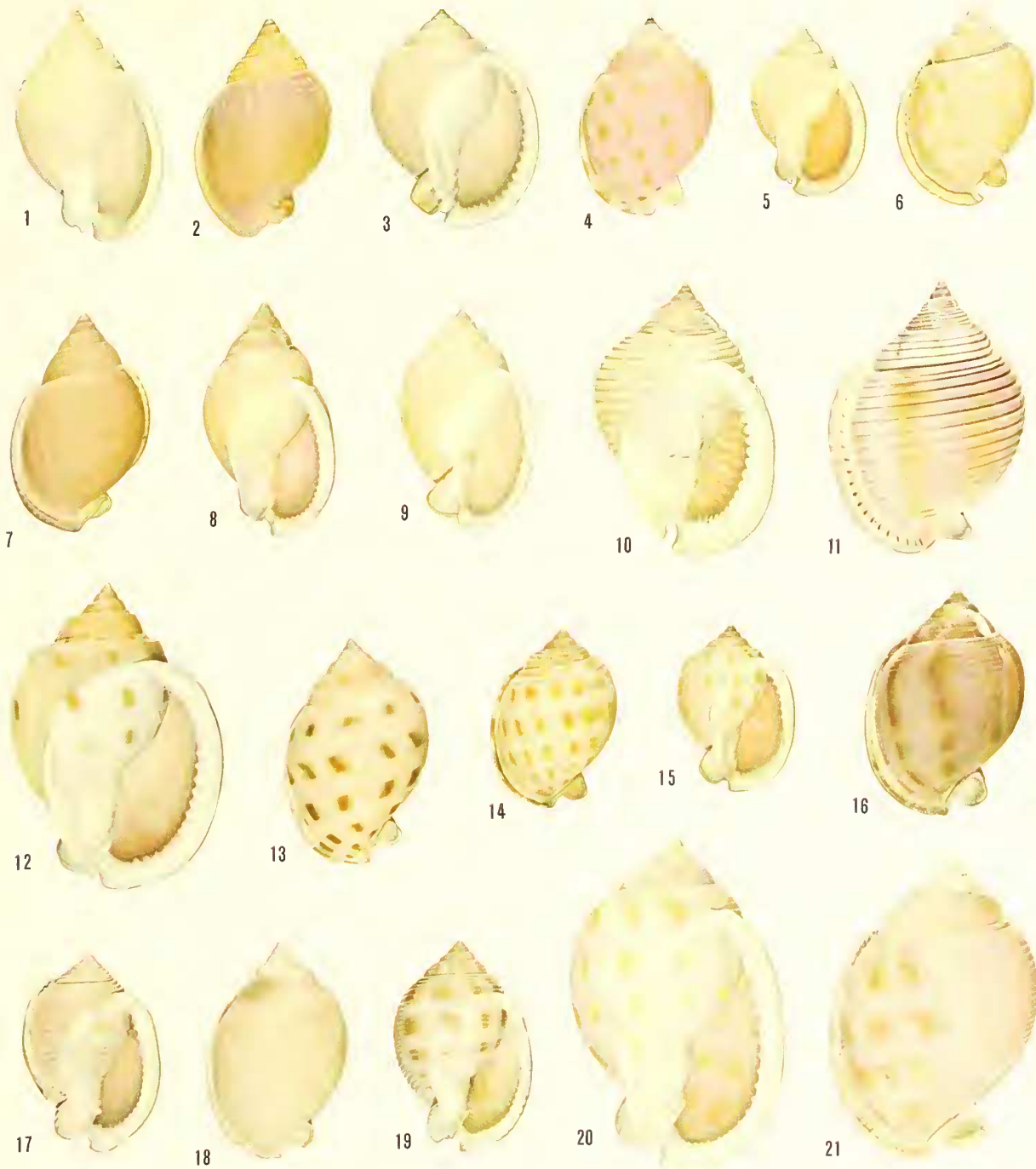


Plate 8

- Figs. 1,2. *Phalium semigranosum* (Lamarck, 1822). 1, Stanley, Tasmania. 2, Encounter Bay, South Australia.
 3,4. *Phalium fauroti* (Jousseaume, 1888). Chango Id., Zanzibar.
 5,6. *Phalium canaliculatum* (Bruguière, 1792). Ceylon.
 7,8. *Phalium glabratum* subspecies *bulla* (Habe, 1961). Ise Bay, Mie-Ken, Honshu Id., Japan.
 9. *Phalium glabratum* subspecies *angasi* (Iredale, 1927). Off Evans Head, New South Wales, Australia.
 10,11. *Phalium umbilicatum* (Pease, 1860). 10, cotype from "Sandwich Isles." 11, off Lahaina, Maui Id.

- 12-21. *Phalium bisulcatum* (Schubert and Wagner, 1828). 12, subspecies *sophia* (Brazier, 1872) off Cape Moreton, Queensland, Australia. 13, smooth form, Mindoro Id., Philippines. 14 and 15, forma *booleyi* Sowerby, 1900; Andaman Islands, Bay of Bengal. 16, striped form, Tabaco Bay, Luzon Id., Philippines. 17, heavy, corded form, 20 fms., south of Aap Li Chaun, Hong Kong. 18, forma *diuturnum* (Iredale, 1927), off Evans Head, N.S.W., Australia. 19, forma *japonicum* (Reeve, 1864), off Tosa, Japan, 50 fms. 20 and 21, forma "*persimile* Kuroda," Mogi, Nagasaki Prefecture, Japan.
 (all 2/3 natural size)

minor radular differences. However, it should be noted that several authors have recently recorded sexual dimorphism in the radulae of other families (V. O. Maes, 1966, *Nautilus*, vol. 79, no. 3, pp. 73-80; Arakawa, K., 1958, *Venus*, vol. 19, pp. 206-216). I have not examined a sufficient number of radulae of cassids to verify the existence of this kind of sexual dimorphism in the *Cassidae*.

I believe that *Phalium sophia* from New South Wales, Australia, is probably a hybrid of *P. pyrum* of cool waters and *P. bisulcatum* of tropical waters where the distributions of these two species, representing different subgenera, overlap. A discussion and illustrations are presented under the treatment of the various species. Crossbreeding experiments, correlated with field observations, would probably be very fruitful and illuminating.

Evolution within the family

The family appears to have come into being just before or during the Eocene. At that time it appeared in North America and Europe. By the Miocene all of the present-day subgenera were established, and some species of both the Miocene and Pliocene are differentiated very little from those of the Recent.

During the Tertiary there was a tendency towards the development of a strongly recurved siphonal canal and an attending channel or "gutter" just posterior to the canal. Many "cassid" characters, such as the development of a broad, thick parietal shield, and the presence of non-re-absorbed varices, appeared in the early Miocene. These and other characters appeared, disappeared and sometimes reappeared in various unrelated species. Occasionally, two or three of these family characters appear suddenly in Recent species, but are absent in their Pliocene progenitors. This "inter-twining" of important subgeneric-like characters within one or more species makes it impossible to create a nomenclatorial and classificatory hierarchy without resorting to numerous monotypic genera. For this reason our treatment is of a "lumping" nature.

Four main stocks within the family have survived to Recent times—*Galeodea*-related, *Sconsia*-related and *Morum*-related genera and the presently treated group of cassid genera, such as *Cassis*, *Phalium*, *Cypraecassis* and *Casmaria*.

Of the 40 living species treated in detail here, 30 show no apparent degree of subspeciation. Ten show subspeciation. The cases of sympatric species within a given genus, such as *Cyprae-*

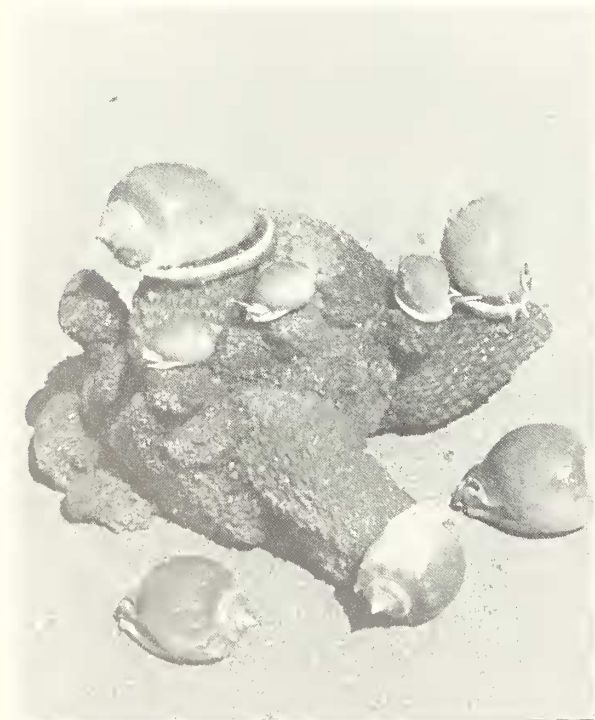
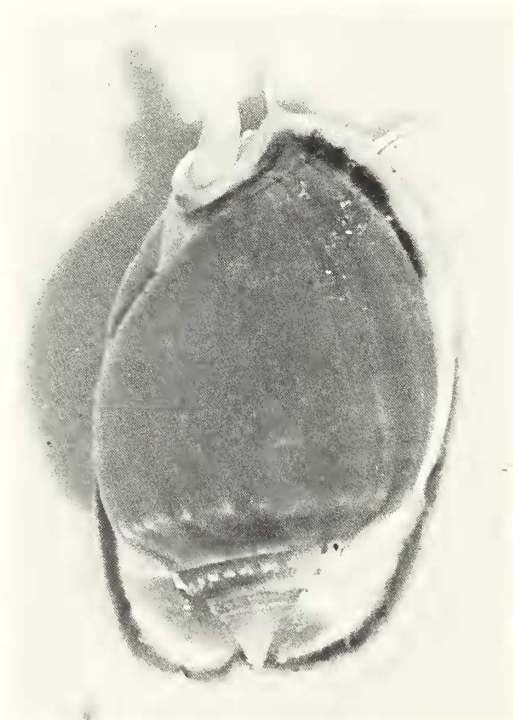


Plate 9. Egg masses of *Phalium glaucum* (Linné). West coast of Malaya, April 1965. Discovered by A. T. Johnson and J. R. Fisher.



Right fig., dorsal view of living *Phalium glaucum* (Linné) from Phuket Island, Thailand (photo by R. T. Abbott).

cassis tenuis and *coarctata*, or such as *Cassis flammea* and *tuberosa*, demonstrate considerable morphological differences and suggest that their origin lies in the Miocene or earlier.

Cassids were more numerous in species and more widely distributed in the Eocene and Miocene. The subgenera *Mauicassis*, *Galeodosconsia* and *Coalingodea* are extinct. *Cassis* was worldwide during the Pliocene, but is now absent in the tropical Eastern Pacific and the Mediterranean Sea.

Among the major mechanisms of evolution is the well-known principle of geographical speciation and its attending isolation. We have been impressed with the dynamic nature of this phenomenon, both in Strombidae (treated in volume 1, no. 2) and the cassids. The evidence from distributional patterns points towards a continual and rather rapid expansion and contraction of geographical limits of many species. This waxing and waning may produce isolated pools, some of which are now worthy of subspecific classification. In connection with changing geographical ranges are varying population densities, which may or may not be correlated with shrinking or expanding distributions. The relative abundance of some species may be influenced by the environment, by inherent genetic changes, or by such

limiting factors as disease, parasites or predators.

As would be expected, every degree of differentiation of geographical isolates are represented among the shallow-water cassids. Some species are very distinctive and show no apparent geographical variation, such as *Cassis cornuta*, *Phalium glaucum* and *Cypraecassis coarctata*. Others show clearly defined subspecies, such as *Phalium glabratum*, *Casmaria ponderosa* and *Phalium bandatum*. A few species show remarkably different forms, due either to minor genetic differences or to ecological influences. *Casmaria erinaceus* (with smooth, light-weight forms or noduled, heavy forms) and *Phalium bisulcatum* (with smooth, colorful forms or coarsely striate, drab forms) are examples of non-geographical variants.

Parenthetically, it should be pointed out that the population samples obtained from deep-water dredgings may be mixtures of colonies representing quite different time origins. Empty shells may represent individuals that lived hundreds or even millions of years ago, the latter being possible if the dredge had sampled a submarine Tertiary outcrop. For these reasons, samples of extreme variability in museum collections do not necessarily represent variations within discrete populations.

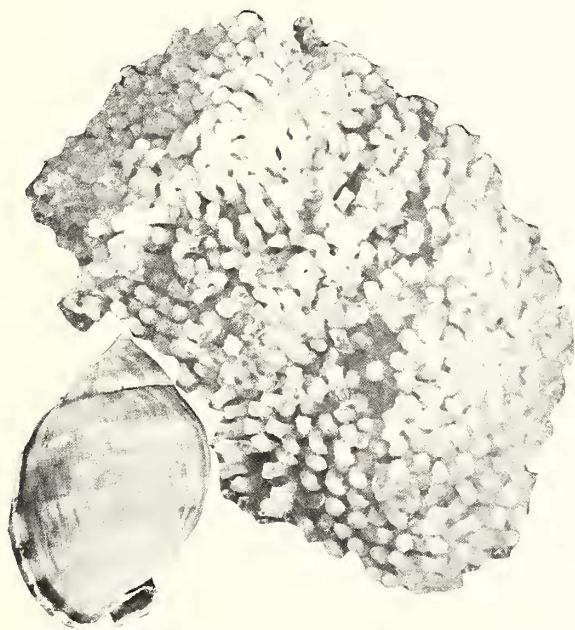


Plate 10. Egg mass (4 in.) of *Phalium labiatum* (Perry) from New Zealand. (from D. T. Anderson, 1966, pl. 10).

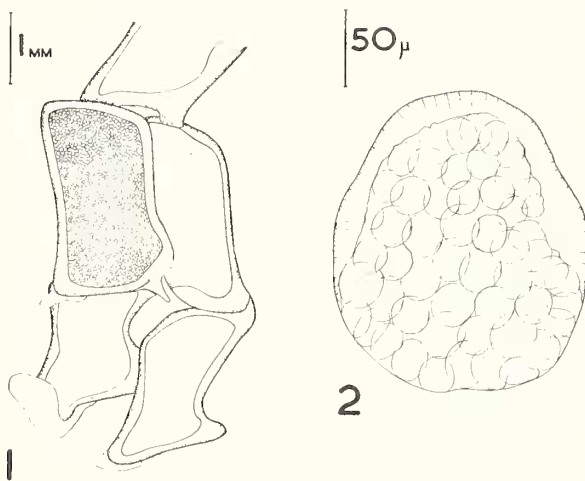


Plate 11. Drawing of egg capsules of *Phalium labiatum* (Perry) from New Zealand. (from D. T. Anderson, 1966, p. 244, figs. 1, 2).



Plate 12

- Figs. 1-7. *Phalium granulatum* (Born, 1778). 1 and 2, *forma cicatricosum* (Gmelin, 1791) from Grand Cayman Id., Caribbean, and Abaco Id., Bahamas. 3, large intermediate form from Bahia, Brazil. 4, typical form from Lake Worth, Florida. 5, *forma peristephes* Pilsbry and McGinty, 1939, from Jensen Beach, Florida. 6, intermediate form from Costa Rica. 7, granulate form from Cape Hatteras, North Carolina.
- 8-10. *Phalium granulatum* subspecies *centiquadratum* (Valenciennes, 1832). 8, Cojimies, Ecuador. 9, off Mazatlan, west Mexico. 10, Acapulco

- 11-15. *Phalium granulatum* subspecies *undulatum* (Gmelin, 1791). 11, 13 and 15 from Melilla, Spanish Morocco. 12, Aci Trezza, Sicily Id., Italy. 14, Algiers, Algeria.
- 16-19. *Phalium saburon* (Bruguière, 1792). 16, Caparica Beach, Lisbon, Portugal. 17, Melilla, Spanish Morocco. 18, Algeria. 19, Melilla, Spanish Morocco; a black, mud-stained specimen.

(all 2/3 natural size)

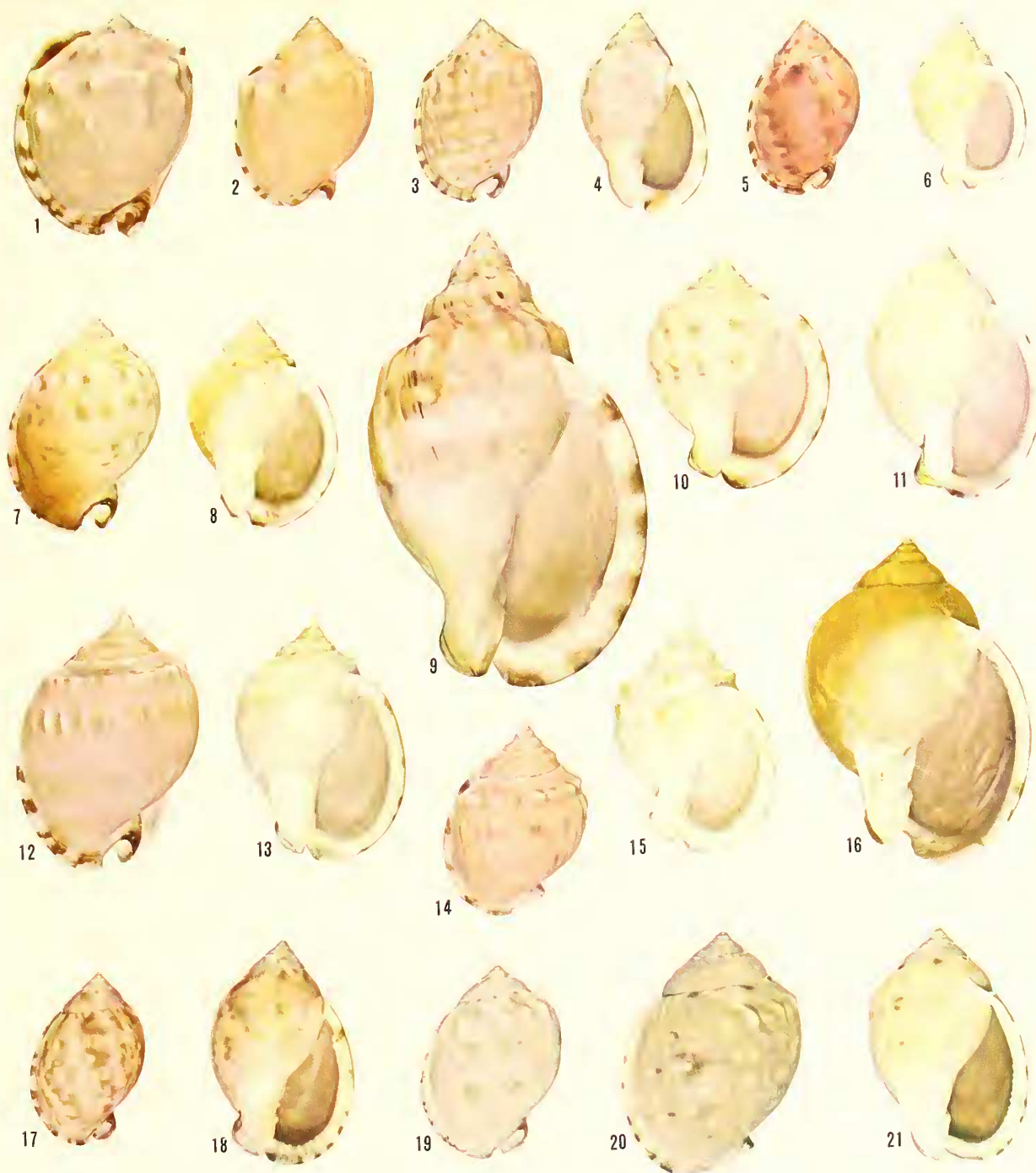


Plate 13

- Figs. 1-5. *Phalium labiatum* subspecies *iredalei* (Bayer, 1935). South Africa. Gradations from the heavy, noded form on the left to the smooth, light-weight, more elongate form on the right.
6. *Phalium inornatum* (Pilsbry, 1895). Wakayama, Honshu Island, Japan.
- 7, 8. *Phalium pyrum* (Lamarck, 1822). North Island, New Zealand.
9. *Phalium pyrum* subspecies *royanum* (Iredale, 1914). 20 fms., off Cavalli Islands, New Zealand.
10. *Phalium pyrum* forma *harrisonae* (Powell, 1928). Stewart Island, New Zealand.
11. *Phalium pyrum* forma *stadiale* (Hedley, 1914). New South Wales, Australia.

12. *Phalium pyrum* forma *spectabile* (Iredale, 1929). Victoria, Australia.
13. *Phalium pyrum* forma *niveum* (Brazier, 1872). South Australia.
- 14, 15. *Phalium thomsoni* (Brazier, 1875). Ulladulla, New South Wales.
16. *Phalium pyrum* forma *finlayi* (Iredale, 1927). Off Otago Heads, New Zealand.
- 17-21. *Phalium labiatum labiatum* (Perry, 1811). La Perouse, N.S.W., Australia. 19, forma *insperatum* (Iredale, 1927), N.S.W., Australia. 20, 21, forma *collectum* (Finlay, 1928), New Zealand.

(all 1/2 natural size)

Classification of Cassids

The family name Cassididae has been used for the helmet shells by most authors in recent years, but unfortunately there is a chrysomelid beetle family name, Cassididae Gyllenhal, 1813, in current use, which has priority over the molluscan name established by Blainville in 1825. I am adopting the use of the family name Cassidae Swainson, 1832, which has been used by Orbigny, 1837; Eichwald, 1853; Watson, 1882; Gabriel, 1962, and others. Swainson's use appears in his "Zoological Illustrations," series 2, vol. 3, p. 100.

Linnaeus in 1758 placed the 12 species of cassids known to him in the genus *Buccinum*. For nearly a hundred years, Scopoli's 1777 genus *Cassis* was employed by most authors, Deshayes, in 1844, recognized 30 species in *Cassis*, Reeve 33 in 1848, Kobelt 40 in 1876, Ch. Bayer 69 in 1935 and Salmon 70 in 1948. As the number of species grew, additional genera and subgenera were created to accommodate the various groups. About 25 supraspecific names have been proposed. In this review of the Tertiary and Recent world-wide species, it has been necessary to re-evaluate the genera and attempt to recognize the most meaningful and useful ones. The geological history, radulae, nuclear whorls, soft parts, opercula and egg masses have been used in separating the genera. Unfortunately, the family exhibits a complex network of so-called generic relationships, so that some subgenera are very arbitrarily accepted merely for the convenient grouping of certain species. Of the several attempts to organize the phylogeny of the family (Dall, 1909; Ch. Bayer, 1935, and Iredale, 1927), that of A. Wrigley, 1934, is very similar to the one given here.

I depart from Wrigley's classification in removing the Eocene subgenus *Morionella* Dall from the genus *Cassis* and placing it on a generic level next to the genus *Galeodea*. I raise *Cypraecassis* to generic level, and submerge *Semicassis* to a subgenus of *Phalium*. The genera I accept were well-established by Miocene times.

Below is a listing of the accepted genera, subgenera, species and subspecies of Cassidae appearing in Part 1 of this monograph. Those preceded by a dagger (†) are fossil only. The list contains 162 fossil and living world-wide species and subspecies, of which 55 are living. I recognize 23 species and subspecies in the Recent tropical Indo-Pacific.

List of Recognized Taxa

GENUS *Cassis* Scopoli, 1777

Subgenus *Cassis* s.s. Scopoli, 1777

- cornuta* (Linné, 1758). **Type.** Indo-Pacific.
- †*preangerensis* K. Martin, 1899. Miocene; Indonesia.
- †*depressior* K. Martin, 1879. Miocene; Indonesia.
- tuberosa* (Linné, 1758). Western Atlantic.
- †*delta* Parker, 1948. Miocene; S.E. United States.
- †*subtuberosa* Hanna, 1926. Pliocene; California.
- flammea* (Linné, 1758). Western Atlantic.
- madagascariensis* Lamarck, 1822. Western Atlantic.
- †*sulcifera* Sowerby, 1850. Miocene; Caribbean.
- tessellata* (Gmelin, 1791). West Africa.
- †*jogjacartensis* K. Martin, 1914. Eocene; Indonesia.
- †*mamillaris* Grateloup, 1827. Miocene; Europe.
- subsp. †*bellardii* Michelotti, 1847.
- subsp. †*postmamillaris* Sacco, 1890.
- subsp. †*apenninica* Sacco, 1890.
- subsp. †*nummulitiphila* Sacco, 1890.
- subsp. †*major* Grateloup, 1827.
- subsp. †*retusa* Michelotti, 1861.
- †*jauberti* Cossmann and Peyrot, 1924. Miocene; France.
- †*saccoi* Rovereto, 1900. Oligocene; Italy.
- †*thesei* Brongniart, 1823. Eocene; Italy.
- †*vialensis* Fuchs, 1870. Tertiary; Italy.

Subgenus *Coalingodea* Durham, 1942

- †*tuberculata* Gabb, 1864. **Type.** Eocene; west United States.

Subgenus *Hypocassis* Iredale, 1927.

- fimbriata* Quoy and Gaimard, 1833. **Type.** Australia.
- †*exigua* Tenison-Woods, 1879. Tertiary; Australia.
- †*salisburyensis* Ludbrook, 1958. Pliocene; Australia.
- nana* Tenison-Woods, 1879. Eastern Australia.
- †*torva* (Iredale, 1927). Tertiary; Australia.
- †*textilis* Tate, 1882. Oligocene; Australia.

GENUS *Cypraecassis* Stutchbury, 1837.**Subgenus** *Cypraecassis* Stutchbury, 1837.*rnfa* (Linné, 1758). Type.

Recent; Indo-Pacific.

†*pustulata* (Cox, 1927). Miocene;

East Africa.

testiculus (Linné, 1758). Recent;

Atlantic.

subsp. *senegalica* (Gmelin, 1791).

Recent; Eastern Atlantic.

†*subtesticulus* (Orbigny, 1852). Miocene;

Europe.

†*cypraeiformis* (Borson, 1820). Miocene;

Europe.

†*psendocrumena* (Sacco, 1890). Pliocene;

Europe.

†*subcrumena* (Orbigny, 1852). Miocene;

Europe.

tenuis (Wood, 1828). Recent;

Eastern Pacific.

Subgenus *Levenia* Gray, 1847.*coarctata* (Sowerby, 1825). Type.

Recent; Eastern Pacific.

GENUS *Phalium* Link, 1807.**Subgenus** *Phalium* Link, 1807.*glancum* (Linné, 1758). Type. Recent;

Indo-Pacific.

bandatum (Perry, 1811). Recent;

Western Pacific.

subsp. *exaratum* (Reeve, 1848). Recent;

Indian Ocean.

areola (Linné, 1758). Recent; Indo-Pacific.subsp. †*vavakuana* (Ladd, 1934).

Miocene; Fiji.

subsp. †*glaucoides* (K. Martin, 1879).

Miocene; Java.

†*menkrawitense* Beets, 1941. Miocene;

Borneo.

strigatum (Gmelin, 1791). Recent;

East Asia.

decussatum (Linné, 1758). Recent;

Western Pacific.

†*cancellianum* Nomura, 1935. Pliocene;

Taiwan.

finubria (Gmelin, 1791). Recent;

central Indo-Pacific.

†*darchiaci* Noetling, 1895. Oligocene;

Burma.

Subgenus *Echinophoria* Sacco, 1890.†*intermedium* (Brocchi, 1814).

Type. Tertiary; Italy.

†*rondeleti* (Basterot, 1825). Tertiary;

Europe.

†*megapolitanum* (Beyrich, 1854).

Oligocene; Europe.

†*haveri* (Hoernes and Auinger, 1884).

Miocene; Austria.

coronadoi (Crosse, 1867). Recent;

Caribbean.

subsp. *wyvillei* (Watson, 1886). Recent;

Western Pacific.

†*bituminatum* (K. Martin, 1933). Pliocene;

Indonesia.

†*vandervlerki* (K. Martin, 1933). Pliocene;

Indonesia.

bituberculosum (von Martens, 1901).

Recent; Indian Ocean.

carnosum (Kuroda and Habe, 1961).

Recent; Japan.

knrodai Abbott, 1968. Recent; Japan.†*etchuense* (Hatai and Nisiyama, 1949).

Miocene; Japan.

pilsbryi (Woodring and Olsson, 1957).

Recent; Galapagos.

†*andersoni* Abbott, 1968. Miocene;

Columbia.

†*hadrum* (Woodring and Olsson, 1957).

Pliocene; Panama.

†*apenes* (Woodring, 1959). Oligocene;

Canal Zone.

†*woodringi* (Olsson, 1964). Neogene;

Ecuador.

†*tuberculiferum* (Hupé, 1854). Tertiary;

Chile.

†*taitii* (Conrad, 1834). Eocene;

S.E. United States.

†*trituberculatum* (Weaver, 1912). Eocene;

western United States.

†*dalli* (Dickerson, 1917). Oligocene;

western United States.

†*oconnori* (Dell, 1952). Miocene;

New Zealand.

†*grangei* Marwick, 1926. Miocene;

New Zealand.

†*oneroaensis* (Powell, 1938). Miocene;

New Zealand.

†*hectori* Abbott, 1968. Miocene;

New Zealand.

†*toreuma* (Powell, 1928). Miocene;

New Zealand.



Plate 14

Figs. 1-6. *Casmaria ponderosa* (Gmelin, 1791). 1 and 2, plicate or *nodulosa* Gmelin form, Atiue, Tahiti Id., Society Islands. 3 and 4, smooth form, Ryukyu Islands. 5, subspecies *unicolor* Dautzenberg from Eilat, Red Sea. 6, striped form, *turgida* Reeve, 1848, Bohol Id., Philippines.

7-12. *Casmaria erinaceus* (Linné, 1758). 7, malformed specimen of form *vibex* (Linné, 1758), with extra varix; Bohol Id., Philippines. 8, typical form from Aeri Ids., Geelvink Bay, Dutch New Guinea. 9, striped form of *forma vibex* (Linné, 1758), central Philippines. 10, typical *erinaceus* form, Cuyo Id., Philippines. 11, Polynesian form with sub-sutural flames, Tutuila Id., Samoa. 12, striped

form *erinaceus* (Linné), Bouganville Id.
13, 14. *Casmaria erinaceus nipponensis* Abbott, new subspecies. 13, holotype, Tanabe, Honshu Id., Japan. 14, paratype, Wakayama, Japan.
15, 16. *Casmaria erinaceus atlantica* Clench, 1944. 15, Bimini Id., Bahamas. 16, paratype, MCZ 134574, Matthew Town, Great Inagua Id., Bahamas.
17. *Casmaria erinaceus* subspecies *kalosmodix* (Melvill, 1883). Pearl and Hermes Reef, Hawaiian Islands.
18. *Casmaria ponderosa* form *cernica* (Sowerby, 1888). Mauritius.

(all natural size)

Phalium (Echinophoria) cont'd.

- †*multinodosum* (Powell, 1928). Miocene;
New Zealand.
- †*emilyae* (Laws, 1932). Miocene;
New Zealand.
- †*pollens* (Finlay, 1926). Miocene;
New Zealand.
- †*trinodosum* (Tate, 1889). Oligocene;
Australia.

Subgenus Manicassis Fleming, 1943.

- †*fibratum* Marshall and Murdoch, 1920.
Type. Pliocene; New Zealand.
- †*kaawaense* (Bartrum and Powell, 1928).
Pliocene; New Zealand.
- †*lilliei* (Fleming, 1943). Pliocene;
New Zealand.
- †*marwicki* (Fleming, 1943). Pliocene;
New Zealand.
- †*onishpetensis* Otuka, 1937. Miocene;
Japan.
- †*yokoyamai* Nomura and Hatai, 1933.
Pliocene; Japan.
- †*yabei* Nomura and Hatai, 1933. Pliocene;
Japan.
- †*petrosum* (Conrad, 1849). Miocene;
N.W. United States.
- †*fax* (Tegland, 1931). Oligocene;
N.W. United States.
- †*rex* (Tegland, 1931). Oligocene;
N.W. United States.
- †*apta* (Tegland, 1931). Oligocene;
N.W. United States.
- †*tegalensis* (K. Martin, 1899). Pliocene;
Indonesia.

Subgenus Galeodosconsia Sacco, 1890.

- †*striatulum* (Bellardi and Michelotti, 1841).
Type. Miocene; southern Europe.
- †*calantica* (Deshayes, 1835). Tertiary;
Europe.
- †*striatum* (J. Sowerby, 1812). Tertiary;
Europe.
- †*augnstana* (Wrigley, 1934). Eocene;
England.
- †*brevicostatum* (Conrad, 1834). Eocene;
S.E. United States.
subsp. †*creolum* Palmer, 1947. Eocene;
S.E. United States.
- †*hodgii* (Conrad, 1841). Miocene;
S.E. United States.
- †*imperum* (Conrad, 1833). Eocene;
S.E. United States.

Subgenus Semicassis Mörch, 1852.

- †*bisulcatum* (Schubert and Wagner, 1829).
Type. Miocene-Recent;
Indo-Pacific.
- subsp. *sophia* (Brazier, 1872). Recent;
Australia.
- †*canaliculatum* (Bruguière, 1792). Recent;
Bay of Bengal.
- †*faurotis* (Jousseume, 1888). Recent;
Indian Ocean.
- †*umbilicatum* (Pease, 1860). Recent;
Hawaiian Chain.
- †*multisectum* (Finlay, 1924). Pliocene;
New Zealand.
- †*skinneri* Marwick, 1928. Miocene;
New Zealand.
- †*microstoma* (von Martens, 1903). Recent;
Indian Ocean.
- †*snfflatum* (Tenison-Woods, 1877).
Tertiary; Australia.
- †*mekranicum* (Vredenburg, 1925).
Miocene; India.
- †*oligocalanticum* (Vredenburg, 1925).
Oligocene; India.
- †*sculptum* (J. Sowerby, 1840). Miocene;
India.
- †*denseplicatum* (K. Martin, 1916).
Miocene; Indonesia.
- †*turricula* Dall, 1909. Tertiary;
N.W. United States.
- †*egberti* Schenck, 1926. Oligocene;
N.W. United States.
- †*iani* Schenck, 1926. Oligocene;
N.W. United States.
- †*aequisulcatum* Dall, 1909. Tertiary;
N.W. United States.
- †*oregonense* (Dall, 1909). Oligocene;
N.W. United States.
- †*glabratum* (Dunker, 1852). Recent;
S.W. Pacific.
subsp. *angasi* (Iredale, 1927). Recent;
Australia.
- subsp. *bullo* (Habe, 1961). Recent; Japan.
- †*semigranosum* (Lamarck, 1822). Recent;
southern Australia.
- †*mnelleri* (Tate, 1889). Pliocene;
southern Australia.
- †*adcocki* (Sowerby, 1896). Recent;
southern Australia.
- †*simosum* (Verco, 1904). Recent;
southern Australia.

Phalium (Semicassis) cont'd.

- saburon* (Bruguère, 1792). Recent;
Eastern Atlantic.
subsp. †*adami* (Eichwald, 1830).
Miocene; Europe.
subsp. †*deucalion* (Eichwald, 1830).
Miocene; Europe.
subsp. †*affine* (Philippi, 1847). Tertiary;
Europe.
†*laevigatum* (Defrance, 1817). Pliocene;
Europe.
†*miolaevigata* Sacco, 1890. Miocene;
Europe.
†*grateloupi* (Deshayes, 1850). Miocene;
Europe.
†*incrassatum* (Grateloup, 1834). Miocene;
Europe.
†*bicoronatum* (Beyrich, 1854). Tertiary;
Europe.
†*subsulcosa* (Hoernes and Auinger, 1884).
Miocene; Europe.
†*reticulata* (Bellardi and Micheliotti, 1841).
Miocene; Italy.
†*neumayri* (R. Hoernes, 1875). Miocene;
Europe.
†*hoernes* (Sacco, 1890). Miocene; Italy.
†*striatella* (Grateloup, 1827). Miocene;
Europe.
†*subareola* (Orbigny, 1852). Tertiary;
France.
craticulatum (Euthyme, 1885). Recent;
South Africa.

Subgenus Tylocassis Woodring, 1928.

- granulatum* (Born, 1778). Type. Recent;
Western Atlantic.
subsp. *undulatum* (Gmelin, 1791).
Recent; Eastern Atlantic.
subsp. *centiquadratum* (Valenciennes,
1832). Recent; Eastern Pacific.
subsp. †*aldrichi* Dall, 1890. Miocene;
Florida.
subsp. †*reclusum* (Guppy, 1873).
Miocene; Caribbean.
†*caelaturum* (Conrad, 1848). Oligocene;
Mississippi.

Subgenus Xenophalium Iredale, 1927.

- pyrum* (Lamarck, 1822). Recent; Australia;
New Zealand; South Africa.
subsp. *royanum* (Iredale, 1914). Type.
Recent; Australia-New Zealand.
pauciruge (Menke, 1843). Recent;
Western Australia.
†*radiatum* (Tate, 1889). Miocene;
S.E. Australia.
thomsoni (Brazier, 1875). Recent;
Australia-New Zealand.
whitworthi Abbott, 1968. Recent;
Western Australia.
inornatum (Pilsbry, 1895). Recent; Japan.
†*gradiferum* (Cossmann and Pissarro,
1909). Eocene; India.
†*moniliferum* (Sowerby, 1846). Tertiary;
Chile.
labiatum (Perry, 1811). Recent;
Australia-New Zealand.
subsp. *iredalei* (Bayer, 1935). Recent;
South Africa.
subsp. *iheringi* (Carcelles, 1953). Recent;
Brazil-Argentina.

GENUS Casmaria H. and A. Adams, 1853.

- erinaceus* (Linné, 1758). Recent;
Indo-Pacific.
subsp. *kalosmodix* (Melvill, 1883).
Recent; Polynesia.
subsp. *vibexmexicana* (Stearns, 1894).
Recent; Eastern Pacific.
ponderosa (Gmelin, 1791). Recent;
Indo-Pacific.
subsp. *unicolor* (Dautzenberg, 1926).
Recent; N.W. Indian Ocean.
subsp. *perryi* (Iredale, 1912). Recent;
South Pacific.
subsp. *nipponensis* Abbott, 1968. Recent;
Japan.
subsp. *atlantica* (Clench, 1944). Recent;
Caribbean.

Doubtful Species of Cassids

This section contains names of *Cassis* which are either invalid, unidentifiable, or now known to belong to genera other than those treated in this monograph. They are included so that the index to this section will constitute as complete as possible a catalog of all known *Cassis*, *Phalium*, *Cypræocassis* and *Casmaria* names. The genus *Galeodea* Link (*Cassidaria* Lamarck) will be treated in a subsequent monograph.

In 1787, Mueschen published his "Schediasma Systematis Testaceorum" (pp. 234-494) in the Museum Geversianum (à la Haye, 1787) and employed all of his genera in the plural form or in several word forms. As Winkworth pointed out in 1926 (Proc. Mal. Soc. London, vol. 17, pp. 103-104), none of Meuschen's names should be accepted, since they are not strictly binomial. Curiously, Sherborn listed all the species in his "Index Animalium", and changed each genus to its singular form. Thus "*Cassides chartoprates* Meuschen" is listed as "*Cassis chartoprates* Meuschen". A list of these names appears below. None is valid and none preoccupies later names in *Cassidea* or *Cassis*. There is no nomenclatorial or taxonomic point in properly identifying them: *anus*, *sulcata*, *penita*; *glabrata*, *coacta*, *spirata*, *cuneata*, *chrysostoma*, *glabra*, *pollicaris*, *vellicata*, *arcularia*, *plicata*, *clatrata*, *perlata*, *gibbosula*, *geminata*, *maculata*, *geometrica*, *areolus*, *alveolus*, *striata*, *cicatricosa*, *tuberculata*, *ziczac*, and *chartoprates* (all Meuschen, 1787, pp. 386-395, so-called genus "Cassides").

A number of *nomen nudum* were created by R. B. Newton in 1891 (Systematic List of the Frederick E. Edwards Collection of British Oligocene and Eocene Mollusca in the British Museum, xxviii + 365 pp.). They have crept into the literature over the years, and a few of the names have been subsequently validated, even though they are synonyms (Wrigley, 1934). Nude names are *Cassis contabulata* "Edwards, MS" Newton; *Cassis geminata* "Edwards, MS" Newton (now *Galeodea geminata* Wrigley,

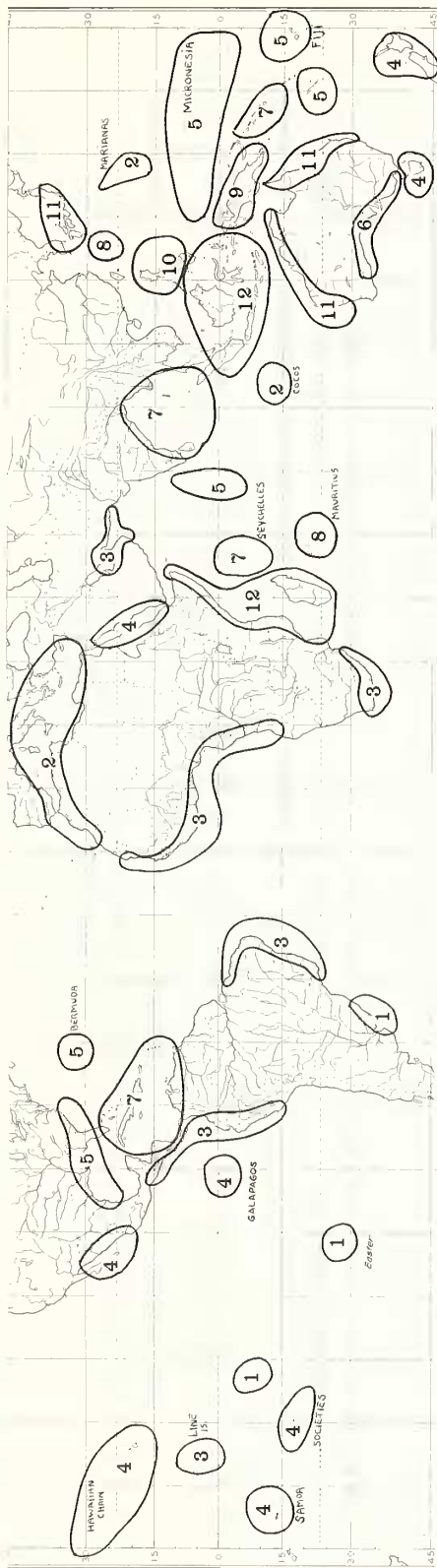


Plate 15. Number of living species and races of cassids inhabiting selected areas of the world (*Cassis*, *Cypræocassis*, *Phalium* and *Casmaria*). Insufficiently collected areas have been omitted, and some of the present censuses will probably increase by about 10 percent when additional records, particularly deep sea ones, are found. For a comparison with a more tropical family, see a similar map of *Strombus*, vol. 1, no. 1, p. 40 [looseleaf p. 09-838].

1934); *Cassis gigantea* "Edwards, MS" Newton (is *Galeodea bullata* T. Brown, 1839); *Cassis nodosa* var. *edentula* "Edwards, MS" Newton (is form *retusa* Deshayes, 1865); *Cassis nodosa* var. *funicincta* "Edwards, MS" Newton (now form *funicincta* Wrigley, 1934); var. *subenodis* "Edwards, MS" Newton (now form *subenodis* Wrigley, 1934); *Cassis spinosa* "Edwards, MS" Newton; *Cassis substriata* "Edwards, MS" Newton (now *Galeodea gallica* form *clarendonensis* Wrigley, 1934); *Cassis tessellata* "Edwards, MS" Newton (now *Sconsia ambigua* form *tessellata* Wrigley, 1934); *Cassis venatrix* "Edwards, MS" Newton (is *Galeodea coronata* Deshayes, 1830).

Cassidea acanthina Dalton, 1908

Range—Miocene of Burma.

Remarks—The large, massive, 100-mm.-long gastropod with two rows of large spines on the lower third of the last whorl very doubtfully belongs to the family Cassidae. No columellar or outer lip characters are preserved in the only known specimen. Dalton assigned it to *Cassidea*, i.e. *Cassis*.

Synonymy—

1908 *Cassidea acanthina* Dalton, Quart. Jour. Geol. Soc. London, vol. 64, p. 629, pl. 57, fig. 1 (1.5 mi. north of Lanywa, Pakokku District, Burma; Miocene).

Cassis aegyptiaca Oppenheim, 1906

Remarks—This poorly preserved and poorly illustrated species may well be a *Tonna*.

Synonymy—

1906 *Cassis aegyptiaca* Oppenheim, Palaeontographica, Cassel, vol. 30, p. 307, pl. 24 (Lutetian, Egypt).

Semicassis anceps H. and A. Adams, 1858

Remarks—This name was proposed for a figure of a living cassid, but the shell represents a young form of either a *Casmaria* or a *Xenogalea*. The type specimen has not been located.

Synonymy—

1858 *Semicassis anceps* H. and A. Adams, Genera of Recent Mollusca, London, vol. 1, p. 215, pl. 23, fig. 2 (no locality).

Cassidea (Semicassis) anteniana K. Martin, 1931

Range—Upper Eocene, Nanggoelan beds of Java, Indonesia.

Remarks—K. Martin likened his species to *Cassidaria desori* d'Archiac and Haime, 1854,

from the Eocene-Miocene, Gáj of Sind, India. I believe both of these species belong to *Galeodea*, and they will be treated in a subsequent monograph.

Synonymy—

1931 *Cassidea (Semicassis) anteniana* K. Martin, Wetenschapp. Mededeel., no. 18, Dienst. Mijnbouw Nederlandsch-Indië, p. 32, pl. 5, figs. 2, 2a (Kali Anten, Nanggoelan beds, Java; Upper Eocene).

Cassis archiaci Bellardi, 1852

Remarks—This fossil may be a *Cypraecassis* or a *Voluta*.

Synonymy—

1852 *Cassis archiaci* Bellardi, Mémoires Soc. Géologique de France, ser. 2, vol. 4, p. 224, pl. 14, figs. 3 and 5 (La Palarea, Nice, France, Tertiary).

Cassidaria arntzenii K. Martin, 1914

Range—Upper Eocene, Nanggoelan beds of Java, Indonesia.

Remarks—As a species, *arntzenii* is very distinctive, but its proper generic placement will be impossible to make until more complete specimens are discovered. The strong distorted teeth on the columella and the spiral cords on the body whorl suggest the genus *Quimalea* in the family Tonnidae. However, there are suggestive features both in the beading of the spiral cords and in the strong plicae on the upper portion of the parietal wall that lead me to believe that this may be a forerunner of the *Tylocassis* or *Semicassis* stock. The unique shell, 21.8 mm. in length, is badly broken and has its apex and siphonal canal absent.

Synonymy—

1914 *Cassidaria arntzenii* K. Martin, Samml. Geol. Reichsmus., Neue Folge, vol. 2, p. 155, pl. 5, figs. 119, 119a (Kali Puru, Nanggoelan beds, Java; Upper Eocene).

1943 *Galeodea arntzenii* (Martin) Beets, Verh. Geol. Mijnbouw Gen. Geol. Serie, vol. 13, pp. 436-437 (Upper Eocene).

Cassis avellana Brongniart, 1822

Remarks—This species belongs to the family Ringiculidae and is the type of the genus *Avellana* Orbigny, 1843.

Cassis beyrichi Michelotti, 1861

Remarks—This is a *Sconsia* from the Oligocene to the Pliocene of Italy, India, Burma and Java (Etude Miocene Infer., p. 132, pl. 13, figs. 7, 8).

Cassis bicatenatus J. Sowerby, 1817

Remarks—This evidently is a fossil species of *Galeodea* described in Mineral Conchology of Great Britain, vol. 2, p. 117.

Cassis bilineata Fleming, 1828

Remarks—What may be either a young *Cypræcassis testiculus* (Linné) or a young *Phalium* (*Semicassis*) *granulatum* (Born, 1778), was figured by Pennant in 1777 in his British Zoology, ed. 4, vol. 4, pl. 79 (bottom figures), and was given the name *Cassis bilineata* by Fleming (1828, Hist. British Animals, p. 339). The name *Buccinum porcatum* Pulteney, 1799 (Cat. Birds, Shells.....Dorsetshire, London, p. 41) was also given to this questionable figure. A more detailed account occurs in Forbes and Hanley, 1853, History of British Mollusca, London, vol. 3, p. 447.

Cassidea breistrofferi Delpey, 1942

Remarks—The poor condition of the shells does not permit assignment of this species to any cassid genus, or in fact, even to the family. In the same paper, Delpey assigns *Fusus sabaudii* Pictet and Roux, 1849, to the genus *Cassidea*, but I question if this species is a cassid.

Synonymy—

1942 *Cassidea breistrofferi* Delpey, Travaux Laboratoire Géol. Univ. de Grenoble, vol. 23, p. 93, pl. 2, figs. 21, 22 (l'Albien inférieur de La Frassette, France).

Cassis brunnea Röding, 1798

Remarks—This name was proposed for Lister's plate 1011, figure 71f which is a *Galeodea* and will be discussed in a future monograph (Museum Boltenianum, Hamburg, pt. 2, p. 30, no. 363).

Cassis caelata Conrad, 1830

Remarks—This small, attractive Oligocene species is, I believe, a *Galeodea*.

Synonymy—

1830 *Cassis caelata* Conrad, Jour. Acad. Nat. Sciences Philadelphia, vol. 6, p. 218.

Cassis callosa Röding, 1798

Remarks—This name is based upon a figure of a *Nassarius* (Knorr, pt. 6, pl. 22, fig. 6).

Cassis canaliculata Risso, 1826

Remarks—This 31 mm.-long, fossil European cassid is unknown to me. It was not illustrated. The name is preoccupied by *Cassis canaliculata* Bruguière, 1792.

Synonymy—

1826 *Cassis canaliculata* Risso, Histoire Naturelle. de L'Europe Méridionale, vol. 4, p. 181 (la Trinité).

Cassis cancellata Röding, 1798

Remarks—Röding in his Museum Boltenianum, Hamburg, pt. 2, p. 30 and 31, described two species by this name, the first probably being a *Nassarius*, and the second being a synonym of *Phalium decussatum* Linné, a Recent species from the southwest Pacific and eastern Asia. I hereby declare both of these as *nomena oblita* in order to preserve the well-known name of the Eocene species, *Cassis cancellata* Lamarck, 1803, and apply to the International Commission on Zoological Nomenclature for action.

Cassidea carinata Bruguière, 1792

Remarks—According to Wrigley, 1934, p. 120, this fossil is a form of *Galeodea nodosa* Solander, 1766. This is also *Cassis carinata* Lamarck, 1803.

Cassis carinata Lamarck, 1803

Remarks—This is a synonym of *Galeodea nodosa* Solander, 1766.

Synonymy—

1803 *Cassis carinata* Lamarck, Annales Mus. Hist. Naturelle Paris, vol. 2, no. 2, p. 169.

Cassis carinata J. Sowerby, 1812

Remarks—This is a homonym and was renamed *Galeodea gallica* Wrigley, 1934, Proc. Mal. Soc. London, vol. 21, p. 123, where he gives a complete synonymy.

Ceiba ceibaensis Clark and Durham, 1946

Remarks—When proposing this new genus and species from the Eocene of Bolivar, Colombia, the authors placed them in the family Cassidae [Cassidae], but considering the volutid-like features of this elongate, narrow shell, and considering the extent to which other members of that fauna had developed their classic Tertiary features, I am more inclined to place

Ceiba in the Volutidae rather than the Cassidae. The original descriptions appeared in Memoir no. 16, Geological Society of America, Washington, vol. 16, p. 33, pl. 21, figs. 8, 10, 13-16, 19.

***Cassidea* (*Semicassis*) *colongoi* Negri, 1934**

Remarks—This Paleogene fossil from Haifat, near Cufra, Fezzan, North Africa, is so poorly preserved that its placement in the correct genus is not possible. It could be a young *Cassis* or an immature *Phalium* (*Semicassis*).

Synonymy—

1934 *Cassidea* (*Semicassis*) *colongoi* Negri, Missione Scientifica Reale Accad. Italia a Cufra, Roma, vol. 3, p. 160, pl. 14, figs. 10 a-c (Haifat; Zella-Marada).

***Cassis conica* K. Martin, 1881**

Range—Tertiary of East Java, Indonesia.

Remarks—I doubt if this species can be assigned to either the cassids or Tonnidae until additional and more complete specimens are found.

Synonymy—

1881 *Cassis conica* K. Martin, Samml. Geol. Reichs-mus. Leiden, series 1, vol. 1, p. 121, pl. 8, fig. 2 (Wirosari, East Java; Neogene).

***Cassis coronata* Deshayes, 1830**

Remarks—Originally described in the Encyclopédie Méthodique (Vers), vol. 2, pt. 1, p. 209, this species was properly transferred to *Cassidaria* [*Galeodea*] by Deshayes in 1835. It was illustrated again by Wrigley, 1934, pl. 17, figs. 36, 37, 38. The name is preoccupied by *Cassis coronata* Röding, 1798. According to the synonymy given by Wrigley, 1934, p. 127, the next available name would be *venatrix* "Edwards" R. B. Newton, 1891, but that name is nude. A new name is required.

***Cassis corrugata* Swainson, 1822**

Remarks—The description of this un-illustrated shell is too brief to determine which of the cassids from the Galapagos Islands it might be. It was described on p. 5 of the appendix to the Catalogue of Shells..... of Mrs. Bligh, London, 1822. On page 24, lot 367, the locality is given as South Seas. I agree with Emerson and Old, 1963 (American Museum Novitates, no. 2153, p. 16) that it should be considered a *species inquirenda*.

***Cassis corsicanus* Locard, 1877**

Remarks—Lack of details of the columella and outer lip make it difficult to assign this poorly preserved Tertiary cassid from Corsica to its proper genus.

Synonymy—

1877 *Cassis corsicanus* Locard, Annales Société d'Agriculture Hist. Nat. et Arts Utiles de Lyon, series 4, vol. 9, p. 64, pl. 4, figs. 3, 4 (Casabianda, Corsica).

***Cassis deshayesi* Bellardi, 1852**

Remarks—This is either a *Cassis* or a *Galeodea*.

Synonymy—

1852 *Cassis deshayesi* Bellardi, Mémoires Soc. Géologique de France, ser. 2, vol. 4, p. 223, pl. 14, figs. 2-4 (La Palarea, Nice, France); deshajes [sic] 1855, Mém. Reale Accad. Sci. Torino, ser. 2, vol. 15, p. 183.

***Cassidaria dubia* Noetling, 1895**

Remarks—Vredenburg (1921, p. 269) claims this Burma fossil is a *Cymatium* belonging to the subgenus *Lampusia*. Noetling also named it *Semicassis protojaponica*.

Synonymy—

1895 *Cassidaria dubia* Noetling, Memoirs Geol. Survey India, vol. 27, p. 27, pl. 6, figs. 2, 3.
1901 *Semicassis protojaponica* Noetling, Palaeontologica Indica, new series, vol. 1, pt. 3, p. 295, pl. 19, fig. 15 (Minbu).
1921 *Tritonium* (*Lampusia*) *dubium* (Noetling), Records Geol. Survey India, vol. 51, pt. 3, pp. 269, 289 (Minbu, Burma; Oligocene).

***Cassis elegans* Grateloup, 1827**

Remarks—I have not seen this Miocene species, but from the original drawing I would suspect that it is a true *Cassis* and closely related to *mamillaris* Grateloup, 1827.

Synonymy—

1827 *Cassis elegans* Grateloup, Bull. d'Hist. Nat. Soc. Linnéenne de Bordeaux, vol. 2, no. 7, p. 19 (Gaas Dax, Landes, France); 1840, Conchyl. Fossile Terr. Tert. . . . l'Adour, Atlas, no. 32, *Cassis* pl. 1, fig. 1.

***Cassis eparcyensis* d'Archiac, 1843**

Remarks—This European Triassic gastropod is not a cassid, but possibly an *Orthostomia* Kittl, 1899. It was originally described in Mém. Soc. Geol. France, vol. 5, pt. 2, p. 385.

Cassis fasciata Borson, 1825

Remarks—This fossil is based upon a very poor figure and I cannot place it to genus. It is not *Cassidea fasciata* Bruguière, 1792, which is *Cassis tessellata* Gmelin, 1791, from West Africa. Sacco, 1890, pt. 7, p. 14, relates it to *Cassis mamillaris* Grateloup, 1827.

Synonymy—

1825 *Cassis fasciatus* Borson, Memorie della Reale Accademia Scienze di Torino, vol. 29, p. 309, fig. 29 (Astigiana).

Cassis fuchsi Dreger, 1892

Remarks—I am unable to place this poorly preserved European Tertiary cassid in any particular subgenus. Noszky (1940) described a variety and placed the species in *Galeodocassis*.

Synonymy—

1892 *Cassis fuchsi* Dreger, Annalen des K. K. Naturhistorischen Hofmuseums, Wien, vol. 7, p. 21, pl. 3, fig. 10 (Tertiary; Häring, Tirol).
 ?1940 *Galeodocassis fuchsi* Dreger var. *saccoi* Noszky, Annales Historico-Naturales Musei National Hungarici, pars Mineralogica, Budapest, vol. 33, p. 17, pl. 1, fig. 20 (*sacconi* on plate explanation).

Cassis gibba Risso, 1826

Remarks—This 34 mm.-long, fossil from Magan, France, is unknown to me.

Synonymy—

1826 *Cassis gibba* Risso, Histoire Naturelle. de L'Europe Méridionale, vol. 4, p. 182.

Cassis glans Röding, 1798

Remarks—This is a synonym of the nassariid, *Demoulia abbreviata* Gmelin, 1791, from South Africa.

Synonymy—

1798 *Cassis glans* Röding, Museum Boltenianum, Hamburg, pt. 2, p. 31, no. 373; refers to Conchyl.-Cab., vol. 10, figs. 1463, 1464.

Cassis globulus Menke, 1829

Remarks—This is a synonym of the nassariid, *Demoulia ventricosa* Lamarck (see Mörch, Malak. Blatt., vol. 18, p. 126).

Synonymy—

1829 *Cassis globulus* Menke, Verzeichniss Conchyl.-Sammlung Malsburg, Pyrmont, p. 37, no. 807 (no locality). Non Röding, 1798.

Cassis gracilenta Yokoyama, 1929

Remarks—According to F. S. MacNeil, 1960, U. S. Geol. Survey Prof. Paper 339, p. 82, this species belongs to the nassariid genus *Cyllene* Gray.

Synonymy—

1929 *Cassis gracilenta* Yokoyama, Imperial Geol. Survey Japan, Report 101, p. 46, pl. 3, fig. 4 (Tertiary of Okinawa and Taiwan).

Phalium granulosum Link, 1807

Remarks—From the brief description of this one-inch long shell, I suspect it may be a *Semicassis*, possibly *granulatum* Born, 1778.

Synonymy—

1807 *Phalium granulosum* Link, Beschreibung der Naturalien-Samml., pt. 4, p. 12 (no locality; no figure reference). Non Bruguière, 1792.

Cassis gregorii Schlosser, 1925

Range—Eocene of the Alps

Remarks—This is a poorly preserved fragment of some kind of cassid. Schlosser allied it to *thesei* Brongniart, 1823, and it may be a synonym of it.

Synonymy—

1925 *Cassis gregorii* Schlosser, Abhandl. Bayerische Akademie Wissen. München, vol. 30, p. 111, pl. 4, fig. 4.

Cassis (Phalium) guppyana Maury, 1912

Remarks—This is so poorly preserved and so badly illustrated that I doubt if it will ever be placed in its correct genus.

Synonymy—

1912 *Cassis (Phalium) guppyana* Maury, Jour. Acad. Nat. Sciences Philadelphia, vol. 15, p. 84, pl. 12, figs. 5, 6 (bed no. 8, Soldado Rock, Gulf of Paria, Trinidad, Eocene).

Cassis guttata Röding, 1798

Remarks—This is a *nomen nudum*.

Synonymy—

1798 *Cassis guttata* Röding, Museum Boltenianum, Hamburg, pt. 2, p. 30, no. 366.

Buccinum ignave "Solander" Dillwyn, 1817

Remarks—This is a nude name introduced by Dillwyn in the synonymy of *Buccinum [Phalium] saburon*. It evidently was a manu-

script name for an immature specimen, according to Dillwyn who published it in his Descriptive Catalogue of Shells, vol. 2, p. 594.

***Cassis* (*Semicassis*) *inarimensis* Bellini, 1900**

Remarks—This Tertiary Italian shell is too poorly described and figured to assign it properly. It looks like an elongate *Tylocassis*.

Synonymy—

1900 *Cassis* (*Semicassis*) *inarimensis* Bellini, Bollettino della Soc. Zoologica Italiana, ser. 2, vol. 1, p. 151, fig. 1.

***Semicassis indicus* Douvillé, 1929**

Remarks—This poorly preserved, fragmentary specimen may be related or synonymous with other Lower Eocene Indian cassids, such as *Phalium* (*Xenophalium*) *gradiferum*.

Synonymy—

1929 *Semicassis indicus* Douvillé, Memoirs Geol. Survey of India, Palaeontologia Indica, new ser., vol. 10, no. 3, p. 45, pl. 8, fig. 22 (Jakmari, Sind, India).

***Cassis inermis* Beyrich, 1848**

Remarks—This is a nude name which was subsequently put into the synonymy of *Cassis megapolitana* Beyrich by Beyrich himself in 1854 (Die Conchylien des norddeutschen Tertiärgeländes, Berlin, pt. 2, p. 154).

***Cassis interrupta* Risso, 1826**

Remarks—This 38 mm.-long, fossil European cassid is unknown to me. It was not illustrated.

Synonymy—

1826 *Cassis interrupta* Risso, Histoire Naturelle. de L'Europe Méridionale, vol. 4, p. 181 (Regions coralligènes. App. Eté).

***Phalium kanmonensis* Hirayama, 1956**

Remarks—This species is based upon poorly preserved material, and it may well be a member of the family Tonnidae or a *Semicassis*.

Synonymy—

1956 *Phalium kanmonensis* Hirayama, Science Reports Tokyo Kyoiku Daig, sect. C, vol. 5, no. 45, p. 121, pl. 8, figs. 10, 11 (Upper Oligocene; Watase Ifukushima, Yamaguchi-ken, Kyushu, Japan).
1960 *Semicassis kanmonensis* (Hirayama), Oyama, Mizuno and Sakamoto, Illustrated Handbook of Japanese Paleogene Molluscs, p. 55, pl. 6, fig. 11.

***Cassis labrosa* Deshayes, 1844**

Remarks—*Cassis labrosa* “Martini” is an invalid name. Deshayes put it in the synonymy of *Quimalea pomum* Linné (Deshayes, 1844, Anim. sans Vert., ed. 2, vol. 10, p. 143).

***Cassis* (*Semicassis*) *lagenaeformis* Boettger, 1883**

Range—Middle Miocene of Nias Id., Indonesia.

Remarks—This species is founded upon a poorly preserved shell and may, indeed, be an internal mold. There are few diagnostic features that would even justify assigning it to *Phalium* or *Semicassis*.

Synonymy—

1883 *Cassis* (*Semicassis*) *lagenaeformis* Boettger, Jarrboek van het Mijawegen in Nederl. Oost-Indië, vol. 12, p. 192, pl. 8, figs. 5a-c (Middle Miocene, Nias Id.); 1915, Zwierzycki, loc. cit., Verhandelingen for 1913, p. 105 (Kroë, Benkoelen, Sumatra).

***Cassis latissima* Rigacci, 1866**

Remarks—This is evidently a museum label name and a *nomen nudum* added to Cat. Conch. Collezione Rigacci, Rome, p. 44, no. 4312 (America). It could be a *Cassis tuberosa* (Linné) with a broad parietal shield.

***Cassis lineata* H. Karsten, 1849**

Remarks—This is a ½-inch-long fossil cassid of unknown locality. Although it is probably a young *Phalium*, the description is not detailed enough to assign it to its probable genus. I am indebted to Dr. Harald A. Rehder for supplying the original publication that was not available to me.

Synonymy—

1849 *Cassis lineata* H. Karsten, Verzeichniss der im Rostocker Acad. Mus. Versteinerungen Sternberger Gestein, Rostock, p. 30 (no. figs.; no locality).

***Cassis malleata* Mörch, 1850**

Remarks—This is a nude name proposed by Mörch in his Catalogus Conchyliorum Kierulf, Hafniae, 1850, p. 13, no. 315 (Antilles), and is probably a *Tylocassis*.

***Cassis?* (*Mangkalia*)
martini Beets, 1941**

Range—Upper Miocene of Mangkal, East Borneo, Indonesia.

Remarks—This species and genus were based upon very incomplete fragments. The holotype is represented by the spire of what appears to be

a *Cassis* (s.s.) or possibly a *Cypraeacassis*, although other families, such as the Fascioliidae and Strombidae should not be overlooked. Until more complete specimens are found, little can be done in assigning either of these taxa to their proper place.

Synonymy—

- 1941 *Cassis?* (*Mangkalia*) *martini* Beets, Verhandelungen Geologisch Mijnbouw Genoots, Nederland en Kolon., vol. 13, p. 87, pl. 5, figs. 187-192 (no locality).

Cassidea menkarae Cuvillier, 1933

Remarks—I cannot place this extremely poorly preserved Egyptian Oligocene specimen in its proper genus.

Synonymy—

- 1933 *Cassidea menkarae* Cuvillier, Mémoires l'Institut d'Egypte, new series, vol. 22, p. 49, pl. 6, figs. 7, 8 (Bortonien, 1 km. south of the third pyramid of Giza, Egypt).

Cassis mississippiensis Conrad, 1847

Remarks—This is a *Galeodea* from the Oligocene of Mississippi.

Synonymy—

- 1847 *Cassis mississippiensis* Conrad, Proc. Acad. Nat. Sci. Philadelphia, vol. 3, pt. 11, p. 288 (Vicksburg, Miss.).

Cassis nilotica Bellardi, 1854

Remarks—This fossil fragment from the Tertiary of Italy is probably a true *Cassis*, but the species will probably remain dubious until more specimens are obtained. It resembles *cancellata* Lamarck. Oppenheim (1906, Palaeontographica, vol. 30, p. 306) claims that *Cassis tricarinata* Schafhäütl is a synonym.

Synonymy—

- 1854 *Cassis nilotica* Bellardi, Memorie delle Reale Accademia della Scienze di Torino, series 2, vol. 15, p. 183, pl. 2, fig. 1 (Egitto, Italy).
1863 *Cassis tricarinata* Schafhäütl, Süd-Bayerns Lethaea Geognostica, Leipzig, pl. 49, fig. 3 (not seen); 1867. O. Fraas, Aus dem Orient (Geologische Beobachtungen), Stuttgart, p. 146.

Cassis nodulifera Partsch, 1837

Remarks—This is evidently a *nomen nudum* and a manuscript name. I can find no record of its having been described.

Synonymy—

- 1837 *Cassis nodulifera* Partsch, Bronn, Neues Jahrbuch für Mineralogie, Geog. Geol. und Petrefak., Stuttgart, for 1837, p. 417, no. 45 (nude name); 1848, Hoernes, Verz. Fossil-Reste Wien, p. 18 (nude name).

Cassis orbiculata Hoeninghaus, 1831

Remarks—This is evidently a *nomen nudum*. It is not *Cassidaria orbiculata* Risso, 1826, p. 185.

Synonymy—

- 1831 *Cassis orbiculata* Hoeninghaus, Neues Jahrbuch für Mineralogie, Geog. Geol. und Petrefak., Stuttgart, for 1831, p. 146 (nude name).

Cassidea (*Semicassis*) *ormarensis* Vredenburg, 1925

Remarks—This Tertiary gastropod from the nodular shales of Ormara, India, is so poorly preserved that I hesitate to judge whether it is a cassid or a *Tonna* (Memoirs Geol. Survey of India, vol. 50, pt. 1, p. 269, pl. 10, fig. 4).

Phallium peckhamioides Ozaki, 1956

Remarks—Due to Ozaki's misspelling of the genus *Pallium*, this bivalve was listed erroneously among the cassids in the Zoological Record, vol. 94, section 9.

Cassis phillipsi d'Archiac and Haime, 1854

Range—Eocene-Miocene, Gáj of Sind, India.

Remarks—The mold of this shell is so lacking in characters that it is almost impossible to assign it to any cassid genus. It may be an immature specimen of "*Cassis*" *subharpoeformis* d'Archiac and Haime, 1854, from the same locality.

Synonymy—

- 1854 *Cassis phillipsi* d'Archiac and Haime, Descr. des Anim. Fossiles Group Nummulitique de l'Inde, Paris, p. 318, pl. 31, figs. 5, 5a (de la chaîne d'Hala [30 mi. n. of Hyderabad, Sind, India]).

Buccinum plicatum Linné, 1758

Remarks—This is a *species inquirenda*. A full discussion of this discarded name appears in the section on *Phalium fimbria* Gmelin.

Cassidea plicata G. Fischer, 1807

Remarks—The very brief, generalized description, without reference to a figure, does not make it possible to identify this species which G. Fischer allied to *Phalium saburon*.

Synonymy—

1807 *Cassidea plicata* G. Fischer, Muséum Demidoff, Moscow, vol. 3, p. 185, no. 15 (no locality).

***Semicassis protojaponica* Noetling, 1901**

Remarks—This is a second name given to *Cassidaria dubia* Noetling, 1895. See above under *dubia*.

***Brugnonia pulchella* Jeffreys, 1883**

Remarks—A year after describing this new genus and species, Jeffreys published a note stating that this very small snail might be the larval form of *Cassis sulcosa* (*Phalium granulatum* subspecies *undulatum* Gmelin) from the Mediterranean. Were this true, *Tylocassis* of Woodring, 1928, would be a synonym of *Brugnonia* Jeffreys. However, the fact that “the last or body-whorl is disproportionately large and takes up about three fourths of the shell” certainly excludes this from the cassid family. At present, I think it wise to consider the genus and species as indeterminate.

Synonymy—

1883 *Brugnonia pulchella* Jeffreys, Annals and Magazine of Nat. Hist., series 5, vol. 11, p. 398, 399, pl. 16, fig. 7; 1884, *ibid.*, vol. 12, p. 67.

***Cassis pullus* Röding, 1798**

Remarks—This is a *Nassarius*.

Synonymy—

1798 *Cassis pullus* Röding, Museum Boltenianum, Hamburg, pt. 2, p. 28, no. 347; refers to Conchyl.-Cab., vol. 2, fig. 413; Knorr, pt. 6, pl. 22, fig. 5.

***Cassidea punctata* G. Fischer, 1807**

Remarks—The brief, generalized description, without a figure reference, makes it difficult to recognize this species. I have seen a small specimen of *Casmaria erinaceus* (Linné) in the Zoological Museum in Copenhagen bearing this name. I consider it a *nomen oblitum* and a *species inquirenda*.

Synonymy—

1807 *Cassidea punctata* G. Fischer, Muséum Demidoff, Moscow, vol. 3, p. 185, no. 14 (no locality).

***Cassis pygmaea* Muenster, 1835**

Remarks—This is a nude name.

Synonymy—

1835 *Cassis pygmaea* Muenster, Neues Jahrbuch für Mineral., Geog., Geol. Petr., Stuttgart, p. 450.

***Cassidea pyramidata* Cuvillier, 1933**

Remarks—I cannot place this poorly preserved, Egyptian Oligocene species in its proper genus.

Synonymy—

1933 *Cassidea pyramidata* Cuvillier, Mémoires l'Institut d'Egypte, new series, vol. 22, p. 48, pl. 8, figs. 16, 18, 19, 21 (Bortonien, 1 km. south of the third pyramid of Giza, Egypt).

***Cassis ringens* Swainson, 1822**

Remarks—This well-known species belongs to the family Tonnidae, genus *Malea* Valenciennes. See Emerson and Old, 1963, American Museum Novitates, no. 2153, p. 11, for a complete synonymy.

Synonymy—

1822 *Cassis ringens* Swainson, A Catalogue of the shells Bligh Collection., London, p. 7, no. 41, p. 25, no. 393, Appendix, p. 4 (no locality).

***Cassis rotundata* Defrance, 1817**

Remarks—I have not seen this fossil Italian species, and from the description I cannot place it to genus.

Synonymy—

1817 *Cassis rotundata* Defrance, Dictionnaires Sci. Naturelles, Paris, vol. 7, p. 211, no. fig. (Plaisantin, Italy).

***Cassis saussurea* Risso, 1826**

Remarks—This 38 mm.-long, fossil European cassid is unknown to me. It may be close to *Phalium laevigatum* Defrance, 1817.

Synonymy—

1826 *Cassis saussurea* Risso, Histoire Naturelle. . . . de L'Europe Méridionale, vol. 4, p. 182, pl. 6, fig. 83 (Terrains argileux de Magnan).

***Cassisoma semieleigans* Rovereto, 1900**

Remarks—I am unable to place this poorly preserved species in its correct genus, but am inclined to agree with Sacco (1904, p. 98) that it is probably an *Echinophoria*.

Synonymy—

- 1900 *Cassisoma* (*Echinophoria*) *semielegans* Rovereto, Illus. Moll. Foss. Tongr., p. 163, pl. 9, fig. 1 (Italian Tertiary).
 1904 *Cassidea* (*Echinophoria*) *semielegans* Rovereto, Sacco, I Molluschi Terr. Terz. Piemonte & Liguria, pt. 30, p. 98, pl. 21, fig. 1 (Tongriano: Mioglia).

***Cassis* (*Semicassis*) *shubutensis* Aldrich, 1885**

Remarks—This Eocene Mississippi and Mexico cassid is probably a *Galeodea* according to Gardner, 1939, p. 22. She allies it to *Galeodea* (*Galeodaria*) *petersoni* Conrad.

Synonymy—

- 1885 *Cassis* (*Semicassis*) *shubutensis* Aldrich, Journal Cincinnati Society Natural History, vol. 8, p. 147, pl. 2, figs. 5a, b (*Shubuta*, Miss., and Red Bluff; Eocene); 1886, Alabama Geological Survey Bull. 1, p. 33, pl. 2, figs. 5a, b.
 1939 *Galeodea*? (*Galeodaria*) *shubutensis* (Aldrich), Gardner, U.S. Geol. Survey Professional Paper 193-B, p. 22.

***Cassis togatus soldadensis* Maury, 1912**

Remarks—According to Rutsch, 1943, p. 177, this Eocene Trinidad fossil is a *Harpa* of the subgenus *Eocithara*. *Cassis togata* White, 1887, originally described as a *Strombus*, is probably a *Harpa*.

Synonymy—

- 1912 *Cassis togata* var. *soldadensis* Maury, Jour. Acad. Nat. Sci., Philadelphia, vol. 15, p. 86, pl. 12, fig. 7 (Soldado Rock, Gulf of Paria, Trinidad; Eocene).

***Cassis striolata* Risso, 1826**

Remarks—This 46 mm.-long, fossil European cassid is unknown to me. It was not illustrated.

Synonymy—

- 1826 *Cassis striolata* Risso, Histoire Naturelle. de L'Europe Méridionale, vol. 4, p. 182 (la Trinité).

***Semicassis subgranosa* Tate, 1889**

(Pl. 16)

Range—Tertiary of Yorke's Peninsula, Australia

Remarks—This 55-mm.-long cassid is evidently an immature specimen, and I cannot place it with confidence in either *Phalium* or *Echinophoria*. It has a superficial resemblance to the Recent *Phalium semigranosum* (Lamarck).



Plate 16. Type of *Semicassis subgranosa* Tate, 1889, from the Tertiary of Yorke's Peninsula, Australia. Length: 55 mm.

Synonymy—

- 1889 *Semicassis subgranosa* Tate, Trans. and Proc. Royal Soc. South Australia, vol. 11, p. 166, pl. 7, fig. 10 (hard craggy-limestones, Edithburgh, Yorke's Peninsula).

***Cassis subharpaeformis* d'Archiac and Haime, 1854**

Range—Eocene-Miocene, Gáj of Sind, India.

Remarks—It would be difficult to assign this poorly preserved specimen to any of the genera of cassids.

Synonymy—

- 1854 *Cassis subharpaeformis* d'Archiac and Haime, Descr. des Anim. Fossiles Group Nummulitique de l'Inde, Paris, p. 317, pl. 31, fig. 6 (de la chaîne d'Hala, [30 mi. n. of Hyderabad, Sind, India]). Non Sacco, 1890.

***Cassis subintermedia* Orbigny, 1852**

Remarks—This name was applied to Grateloup's very poor figure in his supplemental *Cassis* plate 1, fig. 7. It is possibly a *Galeodonsia*. Orbigny's date of 1847 is evidently a manuscript date. Cossmann and Peyrot (1924, Actes Soc. Linn. Bordeaux, vol. 75, p. 84, pl. 11, figs. 40-41) illustrate quite another species, and possibly a *Eudolium*, under this name.

Synonymy—

- 1840 *Cassis intermedia* Grateloup, Conchyliologie Fossile Terrains Tert. l'Adour, vol. 1, atlas, pl. 46, fig. 7 (non Brocchi, 1814).
 1852 *Cassis subintermedia* Orbigny, Prodrome Paléontologie Stratigraph. Universelle, Paris, vol. 3, p. 90, no. 1671. Refers to Grateloup, pl. 46, fig. 7. Dax, St.-Paul.

Cassis sublaevigaster d'Archiac and Haime, 1854

Range—Eocene-Miocene, Gáj of Sind, India.

Remarks—The mold of this shell is so lacking in characters that it is almost impossible to assign it to any cassid genus.

Synonymy—

- 1854 *Cassis sublaevigaster* d'Archiac and Haime, Descr. des Anim. Fossiles Group Nummulitique de l'Inde, Paris, p. 318, pl. 31, fig. 4 (de la chaîne d'Hala [30 mi. n. of Hyderabad, Sind, India]).

Cassis sulcata Risso, 1826

Remarks—This 40 mm.-long, fossil European cassid is unknown to me. It is not *Phalium sulcatum* Link, 1807. Meuschen's 1787 name, *Cassis sulcata*, is non-binomial.

Synonymy—

- 1826 *Cassis sulcata* Risso, Histoire Naturelle. . . . de L'Europe Méridionale, vol. 4, p. 181 (la Trinité).

Cassis tongriana Sacco, 1890

Remarks—This is an immature and poorly preserved specimen which Sacco originally placed in the subgenus *Casmaria*. He later placed it in *Galeodocassis*. The species is unknown to me, and its placement is doubtful.

Synonymy—

- 1890 *Cassis (Casmaria) tongriana* Sacco, I Moll. Terreni Terziarii Piemonte, pt. 7, p. 26, pl. 1, fig. 22 (Tongriano: Oligocene; Carcare, Dego).
 1900 *Cassisoma (Galeodocassis) tongriana* Sacco, Rovereto, Illustrazione dei Moll. Fossili Tongriani, p. 162.
 1904 *Galeodocassis?* *tongriana* Sacco, Sacco, loc. cit, pt. 30, p. 96.

Galeodea trituberculoides Kanno, 1958

Range—Upper Oligocene of central Japan.

Remarks—Unfortunately, the unique holotype lacks the lower part of the columella and the siphonal canal. For this reason, I hesitate to assign this species to a genus or subgenus. It is probably a *Phalium*, and to judge from the sculpture, I am inclined to place it in the subgenus

Mauicassis, rather than the subgenus *Echinophoria* to which Weaver's *trituberculata* belongs.

Synonymy—

- 1958 *Galeodea trituberculoides* Kanno, Sci. Reports Tokyo Bunrika Daigaku, geol. series, C 6, no. 55, p. 212, pl. 6, fig. 20 (Nenokami sandstone, Upper Oligocene, Hikokubo, Yoshidamachi, Saitama Pref., central Japan).

Cassis tuberculosa Röding, 1798

Remarks—Röding referred to figure 11 on Favanne's plate 26, but this must be a misprint, since all figures in Favanne's edition of "La Conchyliologie" bear letters. There are several species on plate 26 which are warty or tuberculate. I am considering Röding's name as dubious.

Synonymy—

- 1798 *Cassis tuberculosa* Röding, Museum Boltenianum, Hamburg, pt. 2, p. 29, no. 354. Refers to Favanne, pl. 26, fig. 11 [sic].

Cassidea (Semicassis) umbgrovei

K. Martin, 1931

Range—Upper Eocene, Nanggoelan beds of Java, Indonesia.

Remarks—I have not examined the type, and I cannot decide from the poor illustration nor from the description whether this is a cassid or a member of the Tonnidae.

Synonymy—

- 1931 *Cassidea (Semicassis) umbgrovei* K. Martin, Wetenschap. Mededeel., no. 18, Dienst. Mijnbouw Nederlandsch-Indië, p. 33, pl. 5, fig. 3 (Kali Puru, Nanggoelan beds, Java; Upper Eocene).

Cassis zirpoloi Negri, 1934

Remarks—This is a very poorly preserved Paleogene fossil from North Africa, and I suspect it may be a *Tonna*.

Synonymy—

- 1934 *Cassis zirpoloi* Negri, Missione Scientifica Reale Accad. Italia a Cufra, Roma, vol. 3, p. 160, pl. 14, figs. 10 a-c (Haifat, Fessan, North Africa).

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About the author

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Genus *Cassis* Scopoli, 1777

Type: *Cassis cornuta* (Linné, 1758)

The genus *Cassis* consists of seven Recent and about two dozen fossil species. They are characterized by large globular shells which have a broad parietal shield, a strongly upturned siphonal canal, and a thick outer lip bearing tubercles. The foot is broad and flat. The proboscis is retractible. A long, finger-like penis, with an open seminal groove running along its entire length, is located on the right side of the body of the male. The eyes are located at the base of the short tentacles. The horny operculum is proportionately very small and is oblong in shape. The radula ribbon is small and bears about 80 rows of delicate taenioglossate teeth. Each row contains seven teeth. *Cassis* feed mainly on sea urchins. The eggs of this genus are still unknown.

The seven living species are quite different in their characters and have been placed in three subgenera. The nuclear whorls vary considerably, but cannot be used as generic characters, since they bear no correlation with other features, and are in some cases identical to those found in other valid groups, such as *Phalium*, *Semicassis* and *Xenophalium*.

The genus first appeared in the Eocene in Indonesia and Europe. I have removed the subgenus *Morionella* Dall, 1909, from *Cassis* and allied it to *Galeodea* Link, 1807. The genus is absent in the Eastern Pacific and Mediterranean of today.

Subgenus *Cassis* Scopoli, 1777

Type: *Cassis cornuta* (Linné, 1758)

The shells in this genus are large, sometimes reaching a length of 14 inches. The parietal shield is large, thick, and bounded on the left by a large, former varix. There are only five living species, one in the Indo-Pacific, one in West Africa, and three in the Caribbean. The radula formula is 4-1-4; 1-7; 3; 3 (the numbers referring to the denticles on the free ends of the teeth). The operculum is small, horny and oblong.

Synonymy—

- 1772 *Cassida* Brünnich, Zoologiae Fundamenta, Copenhagen and Leipzig, p. 248 (in key only; no species mentioned). The date on the title page is 1771. Non *Cassida* Linné, 1758, an insect.
 1777 *Cassis* "Klein" Scopoli, Introductio ad Historiam Naturalem, Prague, p. 393, no. 71; 1786, Deliciae florae et faunae. . . Austriaca, pt. 2, p. 76 (type by subsequent designation of Dall, 1909, p. 60: *C. cornuta* L.).
 1789 *Cassidea* Bruguière, Encyclopédie Méthodique, vol. 1, pt. 1, p. xv; 1792, pt. 2, p. 414 (type by subsequent designation by Cossmann, 1903, p. 123: *Cassidea cornuta* (Linn.).
 1798 *Cassis* Röding, Museum Boltenianum, Hamburg, pt. 2, p. 28 (type hereby designated: *Buccinum cornutum* L., Gmel.).

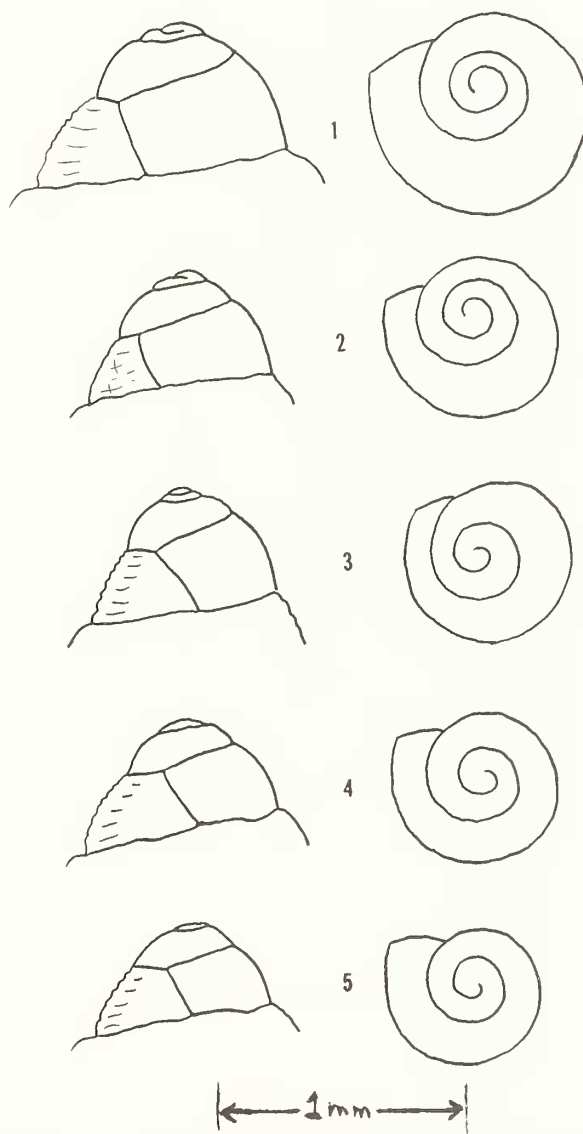


Plate 17. Nuclear whorls of *Cassis* (s.s.). Fig. 1, *cornuta* (Linné). Fig. 2, *tuberosa* (Linné). Fig. 3, *flammea* (Linné). Fig. 4, *madagascariensis* Lamarck. Fig. 5, *sulcifera* Sowerby.

- 1799 *Cassis* Lamarck, "Prodrome", Mem. Soc. Nat. Hist., Paris, vol. 1, p. 72 (type by monotypy: *Buccinum cornutum* L.).
- 1815 *Cassinia* Rafinesque, Analyse de la Nature, p. 45, (emendation for *Cassis* Scopoli). Misspelled *Cassinea* in Dodge, 1956, p. 177.
- 1857 *Goniogalea* Mörch, Catalogus Conchyliorum Suenson, Copenhagen, p. 21, no. 739; 1877, Mörch, Malakozool. Blätter, vol. 24, p. 37 (type by subsequent designation by Cossmann, 1903, p. 124: *C. madagascariensis* Lam.).
- 1882 *Fimbriola* "Megerle MSS" Scudder, Nomenclator Zoologicus, p. 138 (nomen nudum).
- 1890 *Galeodocassis* Sacco, I Moll. Terrenti Terziarii Piemonte Liguria, pt. 7, p. 18 (type by original designation: *G. anceps* Sacco, 1890 = *saccoi* Rovereto, 1900).
- 1899 *Cassisola* Rovereto, Atti. Soc. Ligustica (now Atti Soc. di Scienze e Lettere di Genova), vol. 10, p. 107. New name for *Cassis* Klein, 1753, a non-binomial name.

Nomenclature—The present day use of the name *Cassis* Scopoli did not come into general use until Dall's 1909 revision. Bruguière's genus *Cassidea*, which is now considered a synonym of *Cassis*, was used for various other groups, such as *Phalium*, *Cypraecassis* and *Casmaria*.

Dall was evidently the first to designate a type for *Cassis* Scopoli. Montfort's 1810 designation is for Lamarck's *Cassis*, and does not apply to Scopoli's genus, although the two names refer to the same genus.

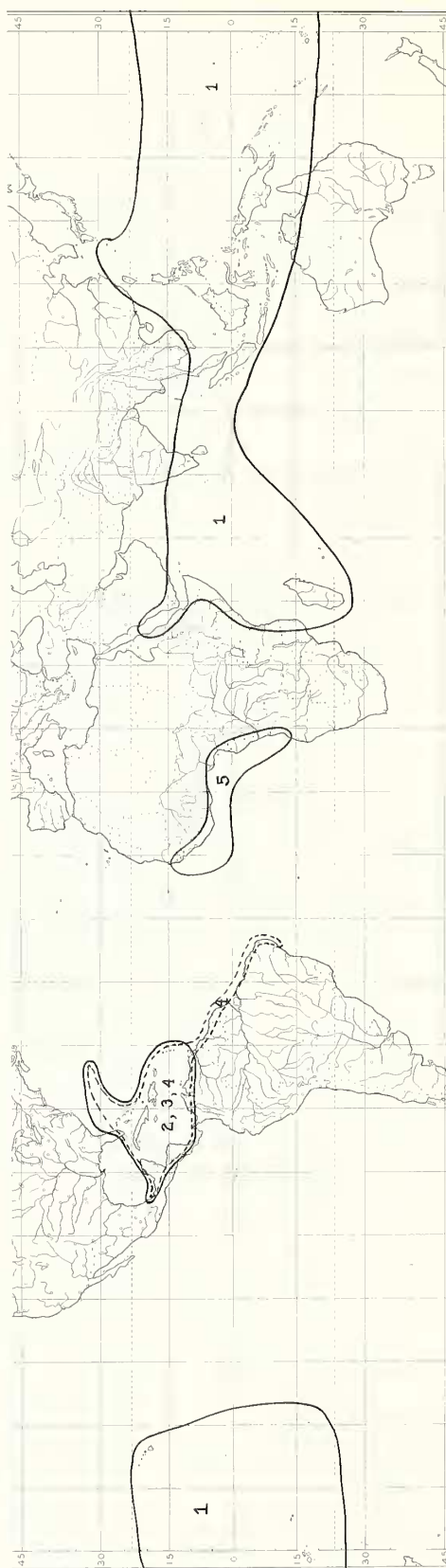


Plate 18. World distribution of Recent *Cassis* (*Cassis*). 1, *cornuta* (Linné); 2, *flammea* (Linné); 3, *madagascariensis* (Lamarck); 4, shown with a dotted line, *tuberosa* (Linné); 5, *tessellata* (Gmelin).

Cassis cornuta (Linné, 1758)

(Pl. 3, figs. 1-4)

Range—East Africa to Polynesia; Japan to Australia. Its distribution broadly coincides with that of coral reefs of the Indo-Pacific.

Remarks—The Horned Helmet is the largest and most widespread of the Indo-Pacific Cassidae. It reaches a length of 14 inches. It is characterized by its large, orange-yellow parietal shield, the row of 5 to 7 knobs on the shoulder of the dorsum, and by the numerous honeycomb-like pittings on the outer surface. Although the shells are variable in several characters, particularly in the coloration and shape of the parietal shield and in the size and number of knobs on the shoulder, I can recognize no consistent differences between Red Sea, East African and Polynesian specimens.

In some areas particularly Hawaii, there appears to be considerable sexual dimorphism in the shells, the males being smaller, less ovate, and having larger and fewer knobs on the dorsum. Young specimens have 9 to 13 small, uniform-sized knobs on the shoulder.

The shell is used by the natives of the South Seas as a container for liquids. It is a popular household shell ornament in many parts of the world, but does not lend itself to cameo carvings.

When shaking a cleaned specimen, one can sometimes hear a small, trapped object inside that defies release even though the shell is slowly rolled in a counterclockwise direction. This has led some shell collectors to suppose that a pearl or piece of broken shell was trapped inside by former varices. However, the object is usually a piece of coral, stone, or shell trapped inside the umbilical region and not within the apertural opening or cavities of the early whorls.

Habitat—*Cassis cornuta* Linné occurs in colonies at depths from 1 to 15 fathoms where the bottom consists of sand and broken coral rock. During periods of inactivity, or perhaps while feeding, they may be partially buried below the surface of the sand. They probably feed on echinoderms. Robert C. Guest (*in litt.*, 1968) reports that "they are more active at night, and when moving they lift their shells straight up, move forward, then drop their shells down."

Description—Adult shell large, 175 to 348 mm. (7 to 14 inches) in length, rotund, with a row of 5 to 7 large or small spines on the shoulder, with a large, oblong, heavy parietal shield, and with a heavy outer lip bearing 5 to 7 large whitish teeth on the central inner edge. Nuclear whorls $2\frac{1}{2}$, minute, bulimoid, opaque-white, smooth, and with a brown suture in the first whorl. Post-nuclear whorls with 5 to 7 irregular, poorly beaded spiral threads. The first varix is produced in the 7th or 8th whorl. Adults with 7 or 8 former varical lips in the spire. Body whorl with 3 or 4 spiral, raised ridges, the upper one on the shoulder bearing 5 to 7 long or short, pointed or broad knobs, while the 2 cords below each bear 3 or 4 very small knobs. There may be an additional low, spiral cord near the base. Outer surface of whorls minutely pitted. Parietal shield heavy, broadly or narrowly elongate, yellowish or brownish orange, with two spotted spiral cords and the surface pitting showing through the central region. Lower half of columella with 8 to 11 poorly developed, whitish, spiral plicae. Outer lip heavy, broad, glossy, cream to orange and with 5 to 7 large teeth on the inner edge in the central region. Posterior side of outer lip usually with 7 broad patches of brown. Umbilicus usually sealed; true umbilicus usually open and containing trapped pieces of loose coral, stones or pieces of shells. Siphonal canal fairly long and pointing upward.

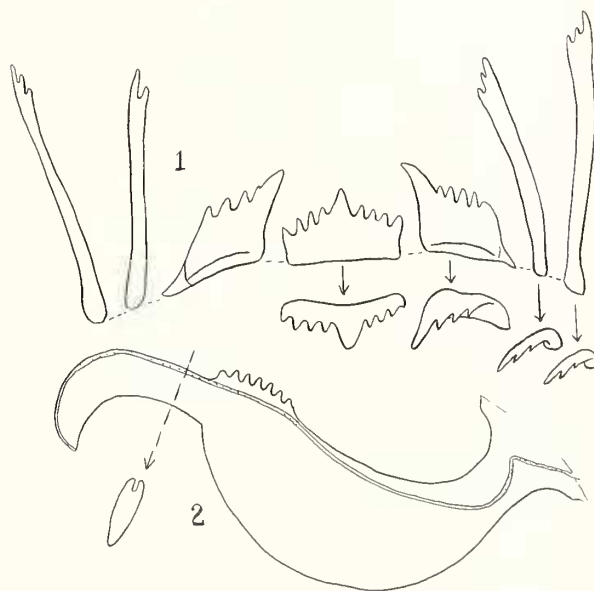


Plate 19. *Cassis cornuta* (Linné), adult male from Okinawa Island, Ryukyus. Fig. 1, row of seven radular teeth. Fig. 2, penis, 120 mm. in length, showing open seminal groove in cross-section.

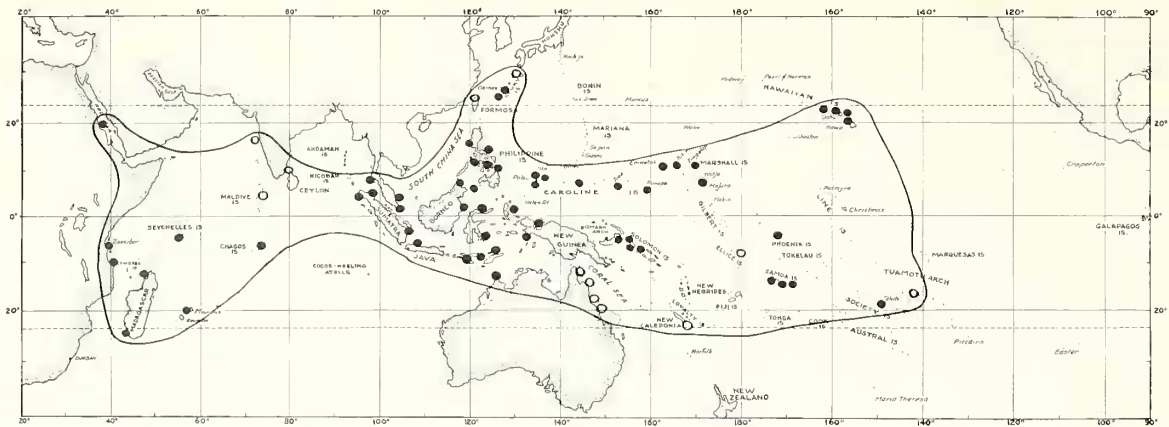


Plate 20. Geographical distribution of *Cassis cornuta* (Linné). Open circles are literature records.

In young specimens less than 60 mm. in length: inner columella with about 14 small, short, spiral plicae; inside of outer lip with 10 to 12 small denticles along the entire length of the outer lip; body whorl maculated with brown and with cancellate sculpturing in which the axial ribs predominate.

Operculum chitinous, brown, elongate-oblong and about $\frac{1}{4}$ the length of the aperture.

Measurements (mm.)—

length	width	no. whorl	no. varices	
312.0 (12.5 inches)	240.0	8+	8	large; Madagascar
310.0	230.0	10	9	large; Cebu, Phil. Ids.
285.0	200.0	7+	8	female, Oahu, Hawaii
253.0	180.0	7+	7+	male; Oahu, Hawaii
225.0	192.0	9+	8	male?; Red Sea
54.5	40.9	8	6	immature; Cebu Id.
17.5	11.8	7	2	immature; Hawaii

Synonymy—

- 1758 *Buccinum cornutum* Linné, *Systema naturae*, ed. 10, p. 735 (in *America* [erroneous]); refers to Buonanni, pl. 155; Rumphius, pl. 23, fig. 1; Gualtieri, pl. 40, fig. D; 1764, *Mus. Lud. Ulricae*, p. 602, no. 249; 1767, ed. 12, p. 1198, no. 445; 1956, Dodge, *Bull. Amer. Mus. Nat. Hist.*, vol. 111, p. 175.
- 1792 *Cassidea cornuta* Bruguière, *Encyclopéd. Méthod.*, Vers, vol. 1, p. 434, no. 17. Non *Cassidea cornuta* Perry, 1811, a *Melongena corona* Gmelin, 1791 (*Conchology*, pl. 34, no. 3).
- 1798 *Cassis caput-equinum* Röding, *Museum Boltenianum*, Hamburg, pt. 2, p. 28, no. 340; refers to *Conchyl.-Cab.*, vol. 2, fig. 362; Lister, pl. 1008.
- 1798 *Cassis hamata* Röding, loc. cit., p. 219; refers to Lister, pl. 1009, fig. 71c.
- 1817 *Cassis labiata* "Chemnitz" Dillwyn, *Descr. Cat. Recent Shells*, vol. 2, p. 589 (in synonymy).
- 1822 *Cassis madagascariensis* Lamarck, *Anim. sans Vert.*, vol. 7, p. 219 [in part, by referring to Rumphius, pl. 23, fig. 1, which is a young *cornuta* Linné].

1885 *Cassis amboinensis* "Petiver" and *brevirostrum* "Petiver", Tryon, *Manual of Conch.*, Philadelphia, vol. 7, p. 271 (in synonymy of *cornuta* Linné).

1916 *Cassis cornuta* Linné, Staub, *Vierteljahrsschrift Naturforschenden Gesellschaft in Zurich*, vol. 61, p. 125, 132 (east Borneo); 1925, Oostingh, *Mededeel. Landbouwhoog. Wagen. Nederl.*, vol. 29, p. 113 (synonymies); 1935, Bayer, *Zoologische Mededeel.*, vol. 18, p. 93-94; 1927, Iredale, *Records Australian Mus.*, vol. 15, p. 327.

1961 *Cassis cornuta* Linné, Weaver, *Hawaiian Shell News*, vol. 9, no. 12, p. 1, fig. of egg mass; vol. 10, no. 2, p. 1, fig. of male and female shell.

Types—Apparently Linné's type specimen is not in existence. A specimen is in the Linnaean collection at Uppsala, Sweden, according to Dodge (1956, p. 177), but was probably not in Linné's possession in 1758 when the species was first described. The type locality "In America" is incorrect. The best of Linné's figure references is to "*Cassis cornuta* Rumphius", pl. 23, fig. 1, which is a young or female specimen.

Records—TANGANYIKA: Inner Sinda Id., Dar-es-Salaam (R. T. Abbott, ANSP); Inner Makatumbe Id., Dar-es-Salaam (J. F. Spry, coll'n). ZANZIBAR: 8 fms., 1- $\frac{1}{2}$ mi. W.S.W. of Ras Nungwi (A. J. Ostheimer, 3rd, ANSP). RED SEA: (Sozon Vatikiotis, ANSP; lower half of Red Sea only, fide A. Hadar *in litt.*). MADAGASCAR: Andilana, Nossi-bé (Ruth Ostheimer); Tuléar (R. W. Foster, MCZ and ANSP). INDIAN OCEAN IDS.: Mauritius (Mauritius Inst.); Seychelles (ANSP); Salomon Id., Chagos Archip. (Eda Couacaud, *in litt.*, 1962); Maldive Ids.: Hulule Id. (E. A. Smith, 1903, p. 611). INDIA: off Bombay (Chari, 1960, *Jour. Bombay Nat. Hist. Soc.*, vol. 53, p. 736); 8-10 fms., Gulf of Manaar, S.E. India (Hornell, 1951, p. 22). MALAYA: east coast, 40 mi. east of Mersing (D. J. Parkinson coll'n). SINGAPORE: Tio-man Id. (Andrew Peters, *in litt.*). JAPAN: Amami-Oshima (Kuroda, 1928, p. 50, Cat. Shell-bearing Moll. Amami-Oshima). RYUKYU IDS.: Mubutu Peninsular, Okinawa Id. (Bernice Albert, ANSP). FORMOSA: Takao (Kuroda, 1941, p. 104). PARACEL IDS.: (E. Saurin, 1961, p. 209). PHILIPPINES: Badang, Sorsogon Prov., Luzon; Cuyo Id.; Borongan, Samar; Olango Id., Cebu Id. (all duPont-Academy Exped., 1958); Siasi, Sulu Archip.; Siquijor Id. (both USNM). BORNEO: 5 fms., Malawali Id., British North Borneo (Mary Saul, ANSP). INDONESIA: Medan, Sumatra; Madura, Java; Billiton Id., Java; Amboina, Ambon Id., Banda Id.; Timor

Id.; Aru Id.; Nias Id.; Obi Id.; Waigeu Id. (all Rijksmus. Nat. Hist. Leiden); Baie de Paloe, Donggala, Celebes; Poeltoetjoch, north Ceram Id. (Priester, Roy. Inst. Nat. Hist. Bruxelles); Geser Atoll, Ceram Id. (N. E. Weisbord, Paleo. Res. Inst.); Tjilang, Atjeh, Sumatra; Sangir Id., north of Celebes; Pekalongan, Java Id. (all Zool. Mus. Amsterdam). NEW GUINEA: Roun Isle, Aeori Ids., Geelvinck Bay (A. J. Ostheimer, 3rd, ANSP); Sorong, Ile Dom (Roy. Inst. Nat. Hist. Bruxelles); Waisor, Wandamen Bay; Fak Fak (both Zool. Mus. Amsterdam). BISMARCKS: Rabaul, New Britain Id. (Schlosser, 1962, ANSP). AUSTRALIA: 15 fms., 125 mi. north of Darwin, Northern Territory (Vernon Wells, ANSP); Wreck Reef and Michaelmas Cay, Queensland (both Aust. Mus.); Green and Low Id., off Cairns, Queensland (Tony Marsh, *in litt.*). SOLOMONS: Choiseul Id. (W. J. Eyerdam, USNM). PALAU IDS.: west barrier reef, Ngauangel; Babelthuap Id.; north end, Kayangel Id. (all A. J. Ostheimer, 3rd., ANSP). CAROLINES: Ulithi Atoll (USNM); Ifalus (USNM); Truk Id. Peter R. Hill, (ANSP). MARSHALLS: Eniwetok Atoll (E. J. Kuenzler, 1960, ANSP); Arno (John Wells); Eniaetok Id., Rongelap Atoll (USNM). NEW CALEDONIA: Hedley, 1899, p. 455). ELLICE IDS.: Funafuti; Nukulaelae (both Hedley, 1899, p. 455). SAMOA: reef at Satalo Id., Upolu Id. (A. J. Ostheimer, 3rd, ANSP); Pago Pago, Tutuila Id. (BPBM). PHOENIX IDS.: Howland Id. (ANSP). SOCIETY IDS.: 5 ft., black sand, Arahiri, Arue Tahiti (R. Robertson, ANSP). TUA-MOTU IDS. (Mus. Nat. Hist., Paris). HAWAIIAN ISLANDS: Niihau Id.; Lanai Id. (both BPBM); Maui Id. (USNM); 40 ft., sand, Rabbit Id., Oahu Id. (C. S. Weaver, ANSP); 4-12 fms., off Launiupoko, Maui Id. (young; D. Thaanum, USNM).

Fossil records—UPPER MIOCENE: Tjilang beds of Java, Indonesia (K. Martin, 1879, p. 45, pl. 8, fig. 5, 5a).

***Cassis preangerensis* K. Martin, 1899**
(Pl. 21)

Range—Middle Miocene, Preangerian; Java, Indonesia.

Remarks—This *Cassis* is not unlike the Recent *cornuta*, but it has a more rugose surface caused

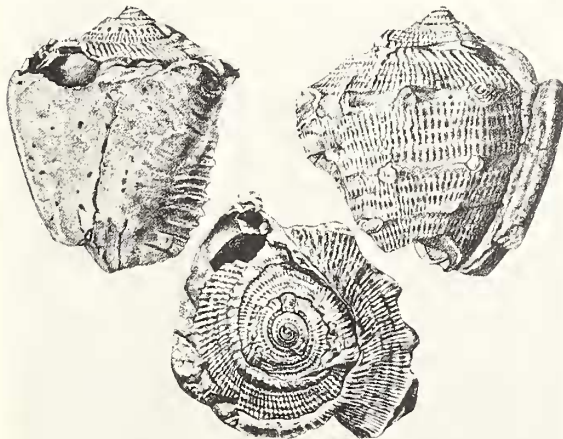


Plate 21. *Cassis preangerensis* K. Martin, 1899. Upper Miocene or Pliocene of Java Island, Indonesia. 62 mm. in (broken) length. (from K. Martin, 1899, pl. 24, figs. 354).

by numerous small axial pittings. The top of the whorls in the spire are also more strongly sculptured than those of *cornuta*. Cossmann (1909, p. 125) thought the age might be Pliocene. R. van Bemmelen (1949, vol. 1A, p. 81) considers the age to be Middle Miocene.

Synonymy—

1899 *Cassis preangerensis* K. Martin, Samml. Geol. Reichsmus. Leiden, Neue Folge, vol. 1, pt. 1, p. 153, pl. 24, figs. 354, 354a, 354b (Preanger-Regentschaften, Java; Upper Miocene).

***Cassis depressior* K. Martin, 1879**
(Pl. 22, figs. 1, 2)

Range—Upper Miocene, Tjilang beds of Java, Indonesia.

Remarks—The type is a very poorly preserved *Cassis* about 65 mm. in length which is characterized by numerous, crowded, long, small, axial riblets. The shell surface lacks the pittings found on specimens of *C. cornuta* (Linné).

Synonymy—

1879 *Cassis depressior* K. Martin, Die Tertiärschichten auf Java, Leiden, p. 44, pl. 8, figs. 4, 4a (Liotjitjankang, near Genung Sela, Tjilang beds of Java; Upper Miocene); 1883, Samml. Geol. Reichsmus. Leiden, ser. 1, vol. 1, p. 219 (Tji Longan at Selatjau, Tjilang beds).

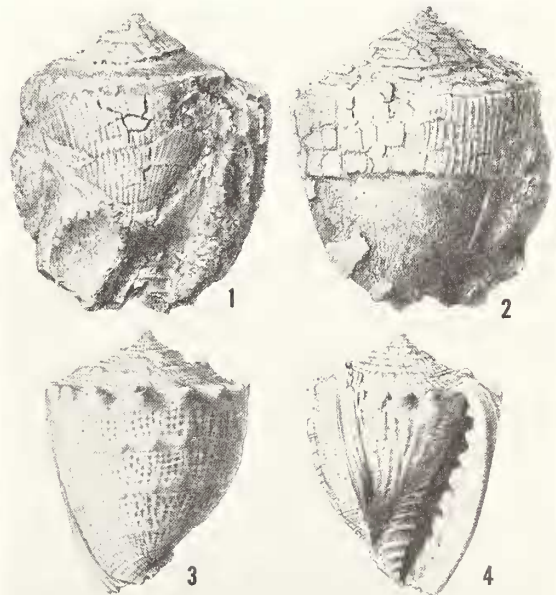


Plate 22. Figs. 1, 2, *Cassis depressior* K. Martin, 1879. Upper Miocene, Tjilang beds, Java Island, Indonesia. (from K. Martin, 1879, pl. 8, fig. 4). Figs. 3, 4, *Cassis cornuta* (Linné) from the same locality. (from K. Martin, 1879, pl. 8, figs. 5, 5a).

***Cassis tuberosa* (Linné, 1758)**

(Pl. 3, fig. 11; pl. 23)

Range—Caribbean province from off North Carolina, Bermuda, and Florida south to Brazil. Miocene of Trinidad.

Remarks—This common West Indian species reaches a length of 4 to 9 inches, and is characterized by its heavy, somewhat triangular parietal shield, by its coarse, reticulated surface and 7 to 8 broad, dark-brown color spots extending over the width of the varices. Very old specimens may have a very pointed parietal shield similar to that found in the fossil species *sulcifera* Sowerby. The species was treated in full by Clench, 1944, pp. 11-12. To the synonymy I add *triangularis* Coulon, 1936, but remove the non-binomial reference of *Buccinum striatum* Meuschen, 1787, which is a turrid. Meuschen's "*Cassides*" occur on pp. 386-395, but none is accepted.

The spines of the sea urchin, *Lytechinus* [*Toxopneustes*] *variegatus* (Lamarck), were found in the digestive tract of this species (Frank

Lyman, 1937, *Nautilus*, vol. 51, p. 34), and the heart urchin, *Clypeaster rosaceus* (Linné), is eaten in the Bahamas by this species (Richard W. Foster, *Nautilus*, vol. 61, p. 35). Off Conch Reef, Lower Florida Keys, this *Cassis* feeds on the white sea urchin, *Tripneustes esculentus* (Leske), according to Donald R. Moore (*Nautilus*, vol. 69, pp. 73-76).

Synonymy—

- 1758 *Buccinum tuberosum* Linné, *Syst. Nat.*, ed. 10, p. 735 (locality unknown); 1767, edition 12, p. 1198, no. 447.
- 1791 *Buccinum striatum* Gmelin, *Systema naturae*, ed. 13, p. 3477, no. 33 (in America); refers to Gronovius, pl. 19, fig. 18.
- 1792 *Cassidea tuberosa* Bruguière, *Encyclop. Méthod.*, vol. 1, pt. 2, p. 436 (Guadeloupe, etc.).
- 1866 *Cassis tuberosa* var. *triquetra* Rigacci, *Catalog. Conch. Collezione Rigacci*, Rome, p. 44, no. 4324 (Bahamas). Nude name.
- 1936 *Cassis triangularis* Coulon, *Bull. Soc. d'Etude Sciences Naturelles d'Elbeuf*, vol. 55, p. 67 [substitute name for *C. tuberosa* Lamarck].
- 1944 *Cassis tuberosa* Linné, Clench, *Johnsonia*, vol. 1, no. 16, p. 11.



Plate 23. A gerontic specimen of *Cassis tuberosa* (Linné) showing the extreme development of the parietal shield caused by excessive deposits of shell material in old age.

Length: 19 cms. (7 1/2 inches). Collected by Daniel Malone, 1968, on Delta Shoals, Marathon, Florida.

Cassis delta Parker, 1948

(Pl. 24, figs. 1, 2)

Range—Miocene of southeastern United States (Chipola formation, Ten Mile Creek, Clarksville, Florida).

Remarks—This medium-sized, very solid *Cassis* is evidently related to *C. tuberosa* (Linné) of the Recent West Indian fauna and to *C. sulcifera* Sowerby, 1850, of the Lower and Middle Miocene of the Caribbean area. It may be a synonym of the latter. It is known only from an adult 134 mm. in length and from three immature specimens.

Synonymy—

1948 *Cassis delta* Parker, Nautilus, vol. 61, no. 3, p. 91, pl. 6, figs. 1, 1a, 1b, 2, 2a, 2b (Bank of Ten Mile Creek on the east side of the bridge of Florida highway no. 84, 4.7 miles north of Clarksville, Calhoun Co., Florida, Chipola formation).

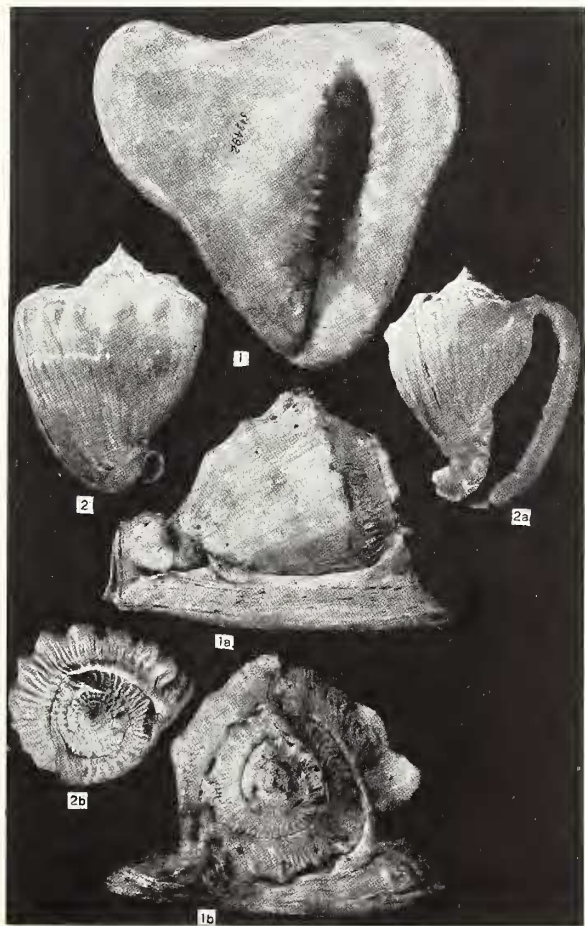


Plate 24. *Cassis delta* Parker, 1948. Miocene, Chipola formation. Ten Mile Creek, Florida. (from Parker, Nautilus, vol. 61, pl. 6). Fig. 1 is 134 mm. in length.

Cassis subtuberosa Hanna, 1926

(Pl. 25)

Range—Lower Pliocene of Imperial County, southern California.

Remarks—This species bears a close resemblance to the Caribbean living *C. tuberosa* (Linné). Schenck (1926, p. 75) said it differs "in having less spinose tubercles, absence of distinct posterior denticles on inner lip, and callus on inner lip more expanded anteriorly." The holotype is 113 mm. (about 5 inches) in length, and about the size of some living and possibly immature *tuberosa* which are as equally weakly spinose. The type (no. 31275) and paratype (no. 31276) are in the Univ. Calif. Coll. Invert. Paleo. according to Schenck.

Synonymy—

1926 *Cassis subtuberosa* Hanna, Proc. Calif. Acad. Sci., 4th series, vol. 14, p. 444, pl. 20, fig. 8; pl. 29, figs. 2, 3 (Alverson Canyon, Coyote Mountain, Imperial Co., Calif.; Lower Pliocene); 1926, Schenck, Bull. Dept. Geol. Sci., Univ. Calif., vol. 16, p. 75, pl. 12, figs. 2 and 3.



Plate 25. *Cassis (Cassis) subtuberosa* Hanna, 1926. Holotype from Imperial County, California. Length: 113 mm. (from Schenck, 1926, pl. 12, figs. 2, 3).

Cassis flammea (Linne, 1758)

(Pl. 3, figs. 7 and 8)

Range—Caribbean province from Bermuda and Florida to the Lesser Antilles.

Remarks—This 3 to 5 inch-long *Cassis* is moderately common in shallow water, and is characterized by its lack of reticulated sculpturing, by its ovate shield, by the lack of brown between the teeth on the outer lip, and by its relatively small size. Clench, 1944, p. 12, treated this spe-

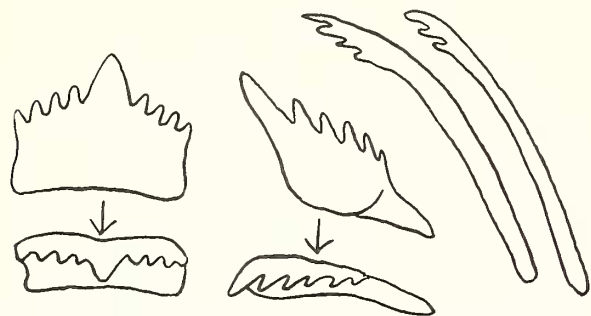


Plate 26. *Cassis flammea* (Linné). Radulae of female from Grenada, Lesser Antilles.

cies in detail. To his synonymy should be added *Cassis marmorata* Röding (1798, p. 29, no. 351; refers to Conchyl.-Cab., vol. 2, figs. 381, 382 and Knorr, pt. 3, pl. 10, figs. 1 and 2). *Cassis alba* Perry, 1811 is also a synonym, as is *Cassis elegans* Grateloup, 1838 (non 1827), Tableau Statist. Coq. Univalves Fossiles, Bordeaux, p. 9, no. 41. Russell Jensen (*in litt.*, 1965) reports this species live from Bermuda. Robert Klein has found it live in 10 to 16 feet of water off Islamorada, Lower Florida Keys.

Cassis madagascariensis Lamarck, 1822

(Pl. 3, fig. 9)

Range—Off North Carolina and Bermuda to the West Indies.

Remarks—This large, moderately common *Cassis* reaches a length of 14 inches and is characterized by its cream-colored exterior and



Plate 27. Operculum of *Cassis madagascariensis* Lamarck. Isla Mujeres, Yucatan, Mexico. Shell, 100 mm.; operculum, 32.5 mm.

a parietal shield which is black and salmon-tinted. The species appears to have two forms which in some areas may be associated with sex differences. The more rotund form with more numerous, smaller nodules, known from North Carolina, the Lower Florida Keys and more recently reported (Warmke and Abbott, 1961, Caribbean Seashells, p. 99) from Puerto Rico was originally described as the subspecies *spinella* Clench, 1944 (*Johnsonia*, vol. 1, no. 16, p. 15, off Tortugas, Florida). *Cassis cameo* Stimpson, 1860, a nude name, is *madagascariensis* Lamarck, 1822. *Cassis rotundata* Perry, 1811 (*Conchology*, pl. 33, no. 1) is also a synonym. The name has not been used for over 100 years, and I reject it, and apply to the I.C.Z.N. for its declaration as a nomen oblitum. *Cassis madagascariensis* var. *major* and *minor* Rigacci, 1866 (*Cat. Conch. Collezione Rigacci*, Rome, p. 44, no. 4314) from the Bahamas, are nude names.

Donald R. Moore (1956, *Nautilus*, vol. 69, pp. 73-76) reports that this species digs in the sand to feed on the giant heart urchin, *Plagiobrissus grandis* (Gmelin) in the Lower Florida Keys. The *Cassis* drills a hole through the thin test or shell of the urchin. Schroeder (1962, *Sea Frontiers*, vol. 8, pp. 156-160) says *Diadema antillarum* (Philippi) is also one of its foods.

Records—(additional since *Johnsonia*, 1944) MEXICO: live and common on Isla Mujeres, Yucatan (Wesley Heilman, 1963, ANSP). NORTH CAROLINA: off Cape Lookout (Hugh Porter, 1964). VENEZUELA: Punta Cardon; Punta Arenas-Esta; Playa Guaigua; Punta Boton; Ensenada Matacual (C. Flores, 1966, p. 13, figs. 2-5). BERMUDA: live, Castle Roads, St. Georges (J. R. H. Lightbourn, 1966).

Fossil records—PLIOCENE: VENEZUELA: Mare Formation, in stream 250 meters S.S.W. of the mouth of Quebrada Las Pailas (N. E. Weisbord, 1962, *Bulls. Amer. Paleont.*, Ithaca, vol. 47, p. 251, pl. 23, fig. 9, 10).

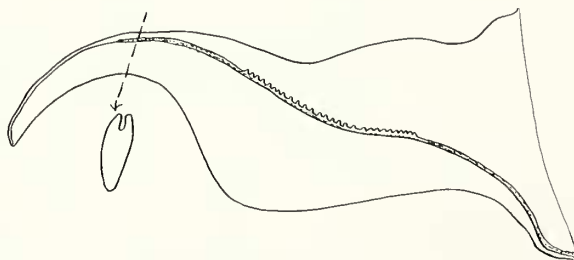


Plate 28. *Cassis madagascariensis* Lamarck. Penis, 100 mm. in length, from male from off Lower Florida Keys, showing the open seminal groove which is bordered by a short row of fleshy serrations.

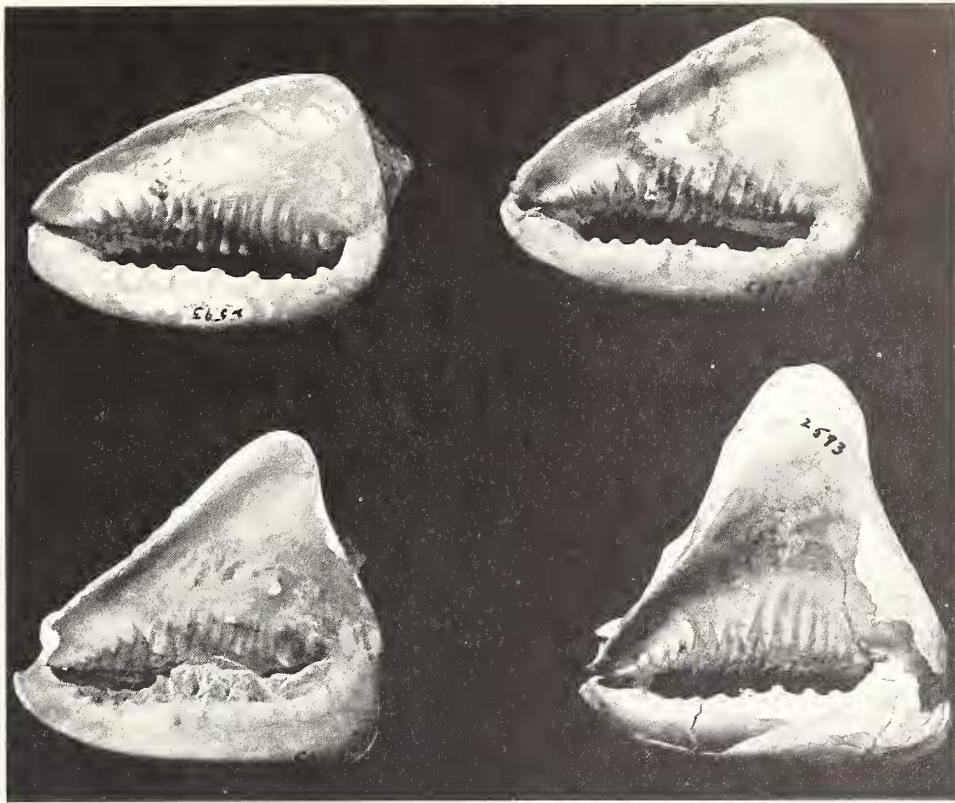


Plate 29. *Cassis sulcifera* Sowerby, 1850, showing variations in the development of the parietal shield. The lower

right figure is the oldest specimen. Miocene of Santo Domingo. Length of top left shell: 62 mm.; others in same scale.

***Cassis sulcifera* Sowerby, 1850**
(Pl. 29)

Range—Lower and Middle Miocene of Panama, Santo Domingo, Jamaica, Trinidad, and Oligocene and Miocene of southeast United States.

Remarks—Woodring (1928, see below) gives a full synonymy up to 1928 of this common Tertiary species of the Caribbean.

Synonymy—

- 1850 *Cassis sulcifer* Sowerby, Quart. Jour. Geol. Soc., London, vol. 6, p. 47, pl. 10, fig. 1 (Santo Domingo; Miocene); 1928, Woodring, Publ. no. 385, Carnegie Inst. Washington, Pt. 2, p. 304-306, 1948, Rutsch, in Stainforth, Amer. Assoc. Petroleum Geologists Bull., vol. 32, pt. 7, p. 1318 (Trinidad; Lower Miocene).
1916 *Cassis sulcifera* Sowerby, Dall Proc. U.S. National Museum, vol. 51, no. 2162, p. 508, pl. 86, fig. 4 (Oligocene, near Bainbridge, Flint River, Decatur County, Georgia, at several localities).
1940 *Cassis flintensis* Mansfield, Journal of Paleontology, Wisconsin, vol. 14, no. 3, p. 214, pl. 27, figs. 47-49 (Flint River, Georgia).

***Cassis tessellata* (Gmelin, 1791)**
(Pl. 3, figs. 5, 6)

Range—West Africa from Senegal south to Loanda, Angola.

Remarks—This is a West African (Dunker, 1853) and not an Australian species as stated by Gmelin (1791), Hedley (1923) and Iredale (1927). Its nomenclature has been confusing, and it has also been called *spinosa* Gronovius and *rumpfi* Gmelin.

Cassis tessellata (Gmelin) reaches a length of about 10 inches (267 mm.), and it is characterized by its comparatively lightweight shell, by the 2 or 3 spiral rows of very small knobs on the upper fifth of the body whorl, by the two axial rows of "teeth" or denticles on the whitish outer lip, and by its strongly beaded spire. It has no close living relative, either in the Caribbean or Indo-Pacific. Superficially, it resembles the South Australian *Cassis fimbriata*, but that species has much larger nuclear whorls, lacks the strong beading in the spire, and has numerous, short, spiral, brown lines on the body whorl.



Plate 30. Geographical distribution of *Cassis (Cassis) tessellata* (Gmelin).

Habitat—This *Cassis* lives offshore on sand bottoms in depths down to about 27 fathoms. Specimens are occasionally washed ashore (Buchanan, 1954, Jour. West African Sci. Assoc., vol. 1, no. 1, p. 36).

Description—Shell 90 to 267 mm. (3½ to 10 inches) in length, somewhat elongate, thin-shelled, with 2 or 3 spiral rows of very small knobs on the upper part of the whorl, and colored a tan-cream with spiral rows of small, crescent-shaped, light-brown spots. Nuclear whorls 3, small, smooth, opaque-tan. Post-nuclear whorls with 3 or 4 spiral threads which are coarsely beaded. Whorls 9 to 10. Shoulder with 2 or 3 spiral rows of fine knobs. Suture irregular and bounded below by numerous, crowded, axially elongated beads. Spire with 8 or 9 former varical lips. Parietal shield poorly developed, allowing the spotted coloration of the whorl to show through. Columella white, with 6 to 8 strong plications in the middle, and with 3 or 4 small, glossy, sharp, round nodules near the base. Outer lip broad, white, rarely with tan spotting, and bearing an inner edge of 8 to 10 strong teeth beside which may be a corresponding second row of sharp nodules. Interior of aperture flushed with dark tan. Body whorl cream or tan and with 8 narrow, spiral bands of alternating patches of white and yellow-brown. Umbilicus sealed or minutely open; false umbilicus narrowly open. Anterior siphonal canal short and leaning to the

left. A short, poorly-developed posterior canal may be produced in some adult specimens. Operculum and soft parts unknown.

Measurements (mm.)—

length	width	no. whorls	no. varices	
267.0	160.0	9+	9	large; Accra, Ghana (AMNH)
218.0	131.0	10+	10	Accra, Ghana (ANSP).
113.6	76.0	10+	8	Gaboon, West Africa
72.3	46.5	9	7	small; "West Africa"

Synonymy—

- [1781 *Buccinum spinosum* Gronovius, Zoophylacium, vol. 3, p. 302, pl. 19, fig. 9. Not binomial]; 1927, Iredale, Records Australian Mus., vol. 15, p. 327.
- 1791 *Buccinum tessellatum* Gmelin, Systema naturae, ed. 13, p. 3476, no. 20 (in Oceano australi); refers to Seba, pl. 73, figs. 1, 12, 13; Conchyl.-Cab., vol. 2, figs. 369, 374. Non Martyn, 1789 which, however, is non-binomial; 1817, Dillwyn, Descriptive Cat. Recent Shells, London, vol. 2, p. 596.
- 1791 *Buccinum maculosum* Gmelin, loc. cit., p. 3476, no. 22 (no locality); refers to Lister, pl. 997, fig. 62. Non Martyn, 1789, a species which was validated in I.C.Z.N. opinion 479.
- 1791 *Buccinum rumpfii* Gmelin, loc. cit., p. 3491, no. 90 (no locality); refers solely to Rumphius, pl. 25, fig. 3; 1923, Hedley, Records Australian Mus., Sydney, vol. 14, no. 1, p. 47.
- 1792 *Cassidea fasciata* Bruguière, Encyclop. Méthod., Vers, vol. 1, pt. 2, p. 430 (mer du Sud); refers to Lister, pl. 997, fig. 62; Seba, pl. 73, figs. 1, 12, 13; Conchyl.-Cab., vol. 2, figs. 369, 374; and to others. Not *Buccinum fasciatum* Brug., which is a *Tonna*.
- 1798 *Cassis coronata* Röding, Museum Boltenianum, Hamburg, pt. 2, p. 29, no. 358; refers to Conchyl.-Cab., vol. 2, figs. 369, 374.
- 1844 *Cassis spinosa* Gronovius, Deshayes, Hist. Nat. Anim. sans Vert., ed. 2, vol. 10, p. 23, footnote; 1848, Reeve, Conch. Icon., vol. 5, *Cassis*, pl. 4, sp. 9 (Australia [error]); 1935, Bayer, Zoologische Mededeel. Rijksmus. Nat. Hist., Leiden, vol. 18, p. 95; 1950, Nicklés, Mollusques Test. Marins Côte Occid. d'Afrique, Paris, p. 85, fig. 129.
- 1927 *Cassis spinosa* (Meuschen), Iredale, Records Australian Mus., vol. 15, p. 327 (Australia).

Types—Gmelin may not have had a specimen of either his *tessellatum*, *maculosum* or *rumpfii*. A type locality was given only for *tessellatum*, but "in Oceano australi" is evidently erroneous. We designate Accra, Ghana, as an appropriate new type locality.

Records—(all West Africa from about 12° North to 10° South latitudes) Cosamance (Nicklés, 1950, p. 85); south of Ile de Orango, N. Lat. 10° 22'; W. Long. 16° 22'. Atlantide Sta. 44, 41-55 meters; off Conakry, N. Lat. 9° 23'; W. Long. 15° 07', Atlantide Sta. 45, 30-34 meters (both Zool. Mus. Copenhagen); Lomé, Togo (David Ogg, ANSP); Robertsport, Liberia (Rijksmus. Nat. Hist. Leiden); Cape Palmas (USNM), Ivory Coast (Nicklés, 1950, p. 85); 50 meters, off Ouidah, Dahomey. A. Crosnier, July 23, 1964; Accra, Ghana (ANSP; AMNH); Sherbro Id. (A. Hurd, Yale Peabody Mus.); Little Eloby Id. (Zool. Mus. Berlin); Sao Thomé Id. (G. R. Batalha, 1878, p. 18); Bay of Cape Lopez (USNM); Duala, Cameroons (Roy. Inst. Nat. Hist. Brussels); Gaboon (ANSP); Loanda, Angola (Dunker, 1853, p. 23).

Fossil records—None recorded.

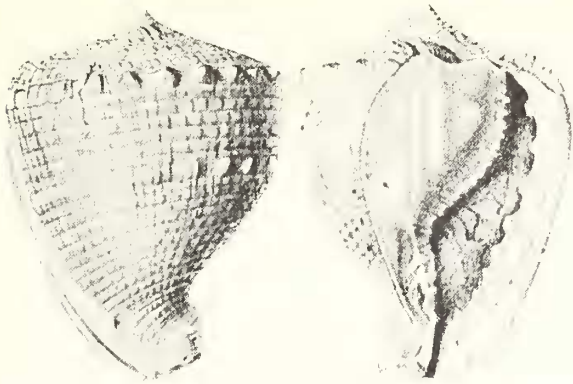


Plate 31. *Cassis jogiacartensis* K. Martin, 1914. Upper Eocene of Java Island, Indonesia. Holotype. 90 mm. in length. (from K. Martin, 1914, pl. 5, fig. 118).

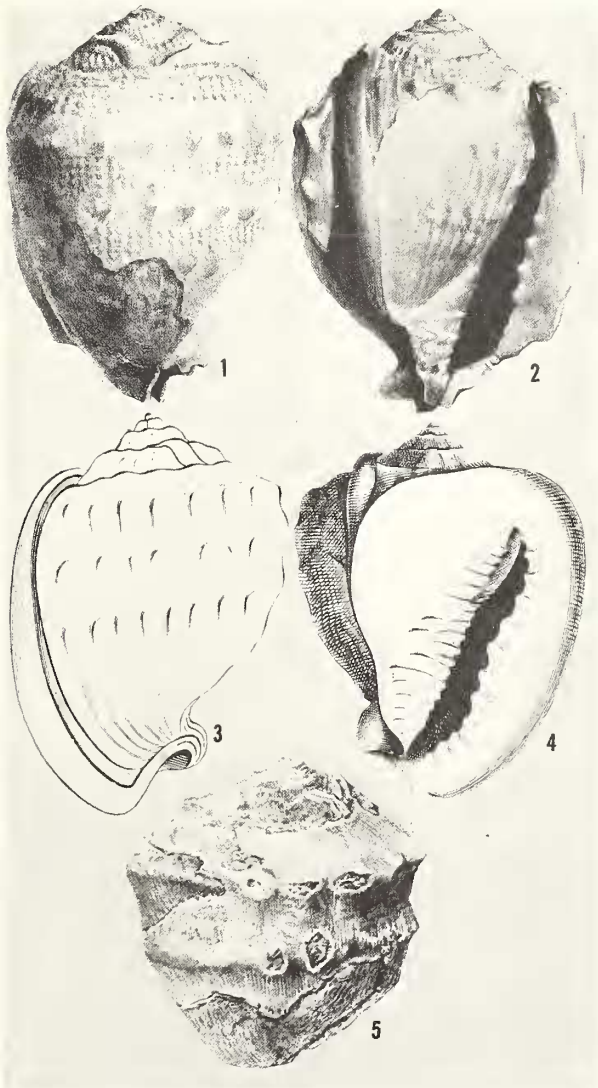


Plate 32. *Cassis mamillaris* Grateloup, 1827. Figs. 1, 2, subspecies *bellardii* Michelotti, 1847. Tertiary of Italy. 123 mm. (from Bellardi and Michelotti, 1841, pls. 4 and 5). Figs. 3, 4, subspecies *major* Grateloup, 1834, Tertiary of France (from Grateloup, 1840, Atlas, vol. 1, suppl., pl. 2, figs. 2a, b.). Fig. 5, subspecies *retusa* Michelotti, 1861. Holotype. Lower Miocene, Italy. 20 mm.

Cassis jogiacartensis K. Martin, 1914 (Pl. 31)

Range—Upper Eocene (?), Nanggoelan beds of Java.

Remarks—This small, 38 mm.-long *Cassis* appears to be distinct from any other members of the genus in having rather strong, round, spiral cords and only one instead of two rows of low knobs on the middle of the last whorl. The small, evenly-sized, rounded knobs on the shoulder are similar to those found in young Recent *Cassis*. The type has 8 whorls and it might be a young specimen.

The Nanggoelan beds in my opinion may be Oligocene, although van Bemmelen (1949, Geol. of Indonesia, vol. 1A, p. 80) does not entirely abandon the view that the age may be Upper Eocene as originally proposed by Martin.

Synonymy—

1914 *Cassis jogiacartensis* K. Martin, Samml. Geol. Reichsmus. Leiden, Neue Folge, vol. 2, p. 154, pl. 5, fig. 118 (Kali Purni, Nanggoelan beds, Java).

Cassis mamillaris Grateloup, 1827

Range—Burdigalian Miocene of France, and Oligocene of Italy and Armenia.

Remarks—The typical *mamillaris* from the Dax in France is a heavy, rather massive cassid with a thick, oval shield, and with crude spiral rows of axially aligned, blunt nodules. A number of forms or closely related species are known from the Tertiary of Europe, but without more material at hand it would be difficult to ascertain the relationships.

The form or subspecies *Cassis mamillaris major* Grateloup, 1834, from Gaas, France (South Aquitainian, Oligocene) is claimed to be distinct from typical *mamillaris* by Cossmann and Peyrot, 1923, p. 72. The form or subspecies *pedemontana* Sacco, 1890, from the Miocene of Torino, Italy, is extremely close to *major*, and may well be a synonym.

Synonymy—

1827 *Cassis mamillaris* Grateloup, Bull. d'Hist. Nat. Soc. Linnéenne Bordeaux, vol. 2, pt. 7, p. 19 (St-Paulles-Dax, Landes, France); 1833, Tableau Coq. Fossile. . . Dax, vol. 6, p. 198; 1840, Conchyliologie Fossile. . . l'Adour Bordeaux, Atlas, vol. 1, pl. 34, figs. 4 and 19; 1963, Glibert, Inst. Royal Sci. Nat. Belgique, Mémoires, ser. 2, fasc. 73, p. 113; 1870, Fuchs, Denkschriften der Kaiserlichen Akademie der Wissenschaften, Math.-Natur., Wien, vol. 30, p. 175, pl. 1, figs. 3, 4; 1961, Aslanyan, Doklady Akad-

emii Nauk SSSR, vol. 136, no. 4, p. 931, fig. 1k (Keara-Molla, Yerevan, S.W. Armenia).

- 1903 *Cassidea mamillaris* Grateloup, Cossmann, Essais de Paléoconchologie Comparée, Paris, vol. 5, p. 124, pl. 5, fig. 10; 1923, Cossmann and Peyrot, Actes Société Linnéenne Bordeaux, vol. 75, p. 71, pl. 12, figs. 12-13 (Aquitaine).

Cassis mamillaris
***subspecies bellardii* Michelotti, 1847**
 (Pl. 32, figs. 1, 2)

Range—Miocene of Turin, Italy.

Remarks—This distinctive form is characterized by its oval shape, and by a peculiar mucronate sculpture between the three rows of evenly-sized nodules.

Synonymy—

- 1841 *Cassis flammea* Brug., Bellardi and Michelotti, Memorie Reale Accademia Scienze di Torino, ser. 2, vol. 3, p. 144, pl. 4, fig. 4, pl. 5, fig. 1.
 1847 *Cassis bellardii* Michelotti, Natuurkundige Verhandel. Hollandsche Maatschappij Wetenschappen te Haarlem, ser. 2, vol. 3, p. 216. Refers to Bellardi and Michelotti, pl. 4, and pl. 5 (La Colline de Turin).
 1852 *Cassis subflammea* Orbigny, Prodrôme Paléontologie Stratigraph. Universelle, Paris, vol. 3, p. 90, no. 1677. Refers to Bellardi and Michelotti, pl. 4, fig. 4, pl. 5, fig. 1.
 1904 *Cassidea mamillaris* var. *bellardii* Micht., Sacco, I Molluschi Terr. Terziari Piemonte e della Liguria, pt. 30, p. 96, pl. 20, fig. 1 (Colli Torinesi).

Cassis mamillaris
***subspecies postmamillaris* Sacco, 1890**

Range—Miocene of Italy.

Remarks—This subspecies of *mamillaris* is characterized by a rather massive, triangular parietal shield, resembling the Recent *Cassis tuberosa* of the Caribbean.

Synonymy—

- 1890 *Cassis postmamillaris* Sacco (and var. *volutilithoides* Sacco) I Moll. Terreni Terziari Piemonte Liguria, pt. 7, p. 16, pl. 1, fig. 11 (Tortoniano: Stazzano, Italy).

Cassis mamillaris
***subspecies apenninica* Sacco, 1890**

Range—Oligocene of Italy.

Remarks—Although this may be an extreme morphological variation of *mamillaris*, I am treating it as a subspecies. In its general shape and well-developed spines it resembles some of the Recent *Cassis* such as young *cornuta* and *tuberosa*.

Synonymy—

- 1890 *Cassis mamillaris* var. *apenninica* Sacco, I Moll. Terreni Terziari Piemonte Liguria, pt. 7, p. 11, pl. 1, fig. 3 (Tongriano: S. Giustina, Carcare, Oligocene).
 1923 *Cassis apenninica* [sic] Sacco, Cossmann and Peyrot, Actes Soc. Linn. Bordeaux, vol. 75, p. 72.

Cassis mamillaris
***subspecies nummulitiphila* Sacco, 1890**

Range—Oligocene of Italy (and India?).

Remarks—This subspecies or form is characterized by its oval shape and by the strong axial plicae on the last whorl. Vredenburg (1925) reported this subspecies from the Miocene, Nari Beds of India, but I suspect that it is probably not identical. He gave the Indian shells the subvariety name *indica*.

Synonymy—

- 1890 *Cassis mamillaris* var. *nummulitiphila* Sacco, I Moll. Terreni Terziari Piemonte Liguria, pt. 7, p. 11, pl. 1, fig. 4, 5a, 5b (Tongriano: Dego, Normese, Carcare, Pareto, etc.).
 ?1925 *Cassidea mamillaris* Grat. var. *nummulitiphila* Sacco, Vredenburg, Memoirs Geol. Survey of India, vol. 50, pt. 1, p. 259 (subvariety *indica*, p. 262).

Cassis mamillaris
***subspecies major* Grateloup, 1827**
 (Pl. 32, figs. 3, 4)

Range—Oligocene and Miocene of France and Italy.

Remarks—The more elongate shape and the three rows of small, somewhat evenly-sized nodules on the body whorl separate this form or subspecies from the typical *mamillaris*. Sacco in 1890 illustrated and named a number of morphological varieties.

Synonymy—

- 1834 *Cassis mamillaris* var. *major* Grateloup, Actes Soc. Linn. Bordeaux, vol. 6, pt. 35, p. 198; 1840, Conchyl. Fossiles. . . l'Adour, vol. 1, pl. 47, fig. 2 (Gaas, France, South Aquitainian, Oligocene).
 1890 *Cassis mamillaris* var. *pedemontana* Sacco, I Moll. Terreni Terziari Piemonte Liguria, pt. 7, p. 13, pl. 1, figs. 6a, 6b (Elveziano: Albugnano and Colline di Torino, Italy, Miocene). Also subvarieties *quinqseriata* Sacco (p. 13), *taurineusis* Sacco (p. 13, fig. 8).
 ?1925 *Cassidea mamillaris* Grat. var. *pedemontana* Sacco, Vredenburg, Memoirs Geol. Survey of India, vol. 50, pt. 1, p. 263 (Gaj of Kachh, India, Miocene).

Cassis mamillaris
***subspecies retusa* Michelotti, 1861**
 (Pl. 32, fig. 5)

Range—Lower Miocene and Oligocene of Italy.

Remarks—This species was based upon a poorly preserved specimen which closely resembles *mamillaris*. Until more specimens are known, its true relationship to *mamillaris* will remain undetermined. Sacco (1890) reported

it from the Oligocene of Italy. (*Cassidaria retusa* Deshayes, 1875, does not preoccupy this name).

Synonymy—

- 1861 *Cassis retusa* Michelloti, Natuurkundige Verhandel. Holland. Maatsch. Wetenschappen te Haarlem, ser. 2, vol. 15, p. 133, pl. 13, figs. 9, 10 (Mioglia, Italy); 1890, Sacco, I Moll. Terreni Terziarii Piemonte Liguria, pt. 7, p. 15 (Dego, Lower Miocene, Italy).

Cassis jauberti (Cossmann and Peyrot, 1924)

Range—Lower Miocene of Aquitaine, France.

Remarks—Although this 96 mm. cassid was originally described as a *Semicassis*, I am assigning it to the genus *Cassis*, for it closely resembles such forms as *Cassis mamillaris* Grateloup of about the same age. It is possible that the peculiar, rather sharp teeth on the parietal wall are a sign that the specimens are not fully mature. In details of sculpture, it resembles *C. mamillaris* subspecies *major* Grateloup, 1834.

Synonymy—

- 1924 *Semicassis jauberti* Cossmann and Peyrot, Actes Société Linnéenne Bordeaux, vol. 75 (for 1923), p. 83, no. 716, pl. 17, figs. 29-31 (Léognan, Burdigalien, France).

Cassis saccoi Rovereto, 1900

Range—Oligocene of Italy.

Remarks—This species is an elongate form showing characters of both *Cypraecassis* and *Cassis*. Sacco proposed the subgenus *Galeodocassis* for this kind of cassid. *Cassis anceps* Sacco, 1890 (non H. and A. Adams, 1858) was re-named *saccoi* Rovereto, 1900. The subgenus has been rejected by most workers, and has been put in the synonymy of *Cassis*.

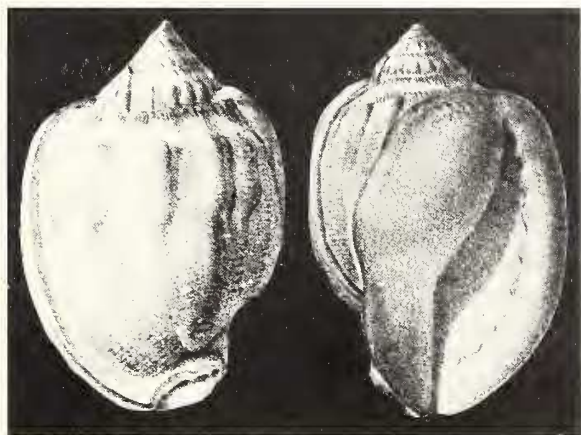


Plate 33. *Cassis thesei* Brongniart, 1823. Eocene of Italy. Holotype. 37.8 mm.

Synonymy—

- 1890 *Cassis* (*Galeodocassis*) *anceps* Sacco, I Molluschi Terreni Terziarii Piemonte, pt. 7, p. 18, pl. 1, fig. 12 (with subvar. *crassinodosa* Sacco, 1890). Non *Cassis anceps* H. and A. Adams, 1858.
1890 *Cassis* (*Galeodocassis*) *subharpaeformis* Sacco, loc. cit., p. 19, pl. 1, fig. 13, Non d'Archiac and Haime, 1854.
1900 *Cassisoma saccoi* Rovereto, Illustrazione dei Molluschi Fossili Tongriani, p. 162, pl. 9, fig. 2. New name for *anceps* Sacco.
1904 *Cassis* (*Galeodocassis*) *sacci* [sic] Rovereto, Sacco, I Molluschi Terr. Terz. Piemonte, pt. 30, p. 96, pl. 20, fig. 2.

Cassis thesei Brongniart, 1823

(Pl. 33)

Range—Eocene of Italy.

Remarks—I have not seen the type of this Italian Eocene species. It is provisionally placed in *Cassis*, although it has some parietal features usually associated with *Phalium*. I believe *Cassis aeneae* Brongniart, described from the same area, is merely a young specimen of *thesei*. *Cassis gregorii* Schlosser, 1925, may be a synonym.

Synonymy—

- 1823 *Cassis thesei* Brongniart, Mémoire sur les Terrains de Sédiment Supérieurs Calcaréo-Trappéens du Vicentin, Paris, p. 66, pl. 3, fig. 7a, b (Ronca, Italy).
1823 *Cassis aeneae* Brongniart, loc. cit., p. 66, pl. 3, fig. 8a, b (Ronca, Italy).
1841 *Cassis thaesei* Brong., Bellardi and Michelotti, Memorie Reale Accademia Scienze Torino, ser. 2, vol. 3, p. 144.
1841 *Cassis oeneae* Brongniart, Bellardi and Michelotti, loc. cit., p. 145.

Cassis vialis Fuchs, 1870

Range—Tertiary of Vicentin, Italy.

Remarks—This is a broken specimen which is either a true *Cassis* or possibly a *Cypraecassis*.

Synonymy—

- 1870 *Cassis vialis* Fuchs, Denkschriften der Kaiserlichen Akademie der Wissenschaften, Math.-Natur. Classe, Wien, vol. 30, p. 172, pl. 1, figs. 1, 2 (Monte Viale, Italy; Tertiary).

[These occasional blank areas occur between genera and subgenera to permit the insertion of new material and future sections in their proper systematic sequence.]

Subgenus *Coalingodea* Durham, 1942

Type: *Cassis* (*Coalingodea*) *tuberculata* Gabb, 1864

This Californian Eocene species appears to be midway between certain European Miocene *Cassis* and living members of the genus *Phalium* s.s. It was previously placed in *Galeodea* by several American workers, and seemed sufficiently novel for Durham (1942, p. 186) to have created a new genus, despite the fact that no specimens having a perfect siphonal canal were known. The "naticoid" nuclear whorls, "honey-comb" sculpture, the existence of several former varices, and the well-developed parietal shield, all suggest the genus *Cassis*, and not *Galeodea*. The sculpturing of the first few postnuclear whorls are also *Cassis*-like, and unlike the numerous, fine spiral threads of *Galeodea*.

The contour and spiral sculpturing or wrinkles on the columella and the thickened outer lip are like those in some *Phalium*. The lack of a "gutter" or groove posterior to the siphonal canal separates this subgenus from all *Phalium* and most, but not all *Cassis*.

For nomenclatural reasons mentioned below, Gabb's name *tuberculata* is not pre-occupied, so that Hanna's replacement name, *tuberculiformis*, need not be used.

Synonymy—

1942 *Coalingodea* Durham, Jour. of Paleontology, vol. 16, no. 2, p. 186 (type by original designation: *Galeodea tuberculiformis* Hanna, 1926 = *Morio* (*Sconsia*) *tuberculatus* Gabb, 1864).

Cassis tuberculata (Gabb, 1864)

(Pl. 34)

Range—Eocene; Domengine in California and Clallum County, Washington.

Remarks—This unique species has been discussed by Vokes (1939, p. 149) and Durham (1942, p. 186) in some detail. In my opinion it is not a *Galeodea*. Vokes made the following descriptive remarks:

"This species may be distinguished from all other West Coast species of *Galeodea* in the possession of a well-developed series of denticles on the outer lip, which is reflected and thickened. Varices on the earlier whorls of the shell are almost universally present, and were observed on all the specimens examined, although Schenck (1926, p. 83) notes that they may be absent.

"The protoconch is naticoid, consisting of 4 smooth whorls, slightly tabulate at the impressed suture. The first succeeding whorl is characterized by 3 well-developed spiral riblets, the sutural riblet being smooth, the anterior two nodose. Approximately one third of the circumference from the end of the protoconch longitudinal ribs appear in the interspaces. On the succeeding whorls fine intercalated spiral threads



Plate 34. *Cassis* (*Coalingodea*) *tuberculata* (Gabb, 1864). Crest of Parson's Peak, Domengine formation, Coalinga, California, Eocene. Length: 20.2 mm. for largest figure. (from Vokes, 1939, pl. 19, figs. 23, 25 and 27).

appear, the nodose character of the most anterior thread becomes accentuated while the middle thread tends to appear beaded, loses its primary distinctness, and is not separable from the other threads on the shoulder of the body-whorl.

"The number of nodose carinae on the body-whorl varies. On the smallest specimen examined the shoulder of the whorl alone is carinated. This is the anterior riblet of the post-nuclear whorl. The other specimens show 2 or 3 carinae. When the anterior carina is not noded its position is marked by a spiral thread, which is slightly stronger in its development than the normal threads on that portion of the whorl."

Durham was in error in saying that the protoconch of *Galeodea* is low and naticoid. It is high, bulbous, and with rapidly descending whorls.

There have been six names of *tuberculata* proposed in Cassidae, but curiously none preoccupy Gabb's 1864 name. *Cassidaria tuberculata* Risso, 1826 (a synonym of *Phalium* (*Echinophoria*) *intermedium* Brocchi, 1814) is neither a primary nor secondary homonym. *Cassidea tuberculata* G. Fischer, 1807 is doubtfully *Phalium fimbria* Gmelin, although it perhaps should be considered a *nomen dubium*. *Cassis tuberculata* Meuschen, 1787, is non-binomial. Weinkauff's 1867 and Sacco's 1890 *tuberculata* are *Phalium*, and unless Gabb's species is placed in *Phalium* or in *Coalingodea* as a full genus by future workers, Hanna's replacement name of *tuberculiformis* need not be used.

I am provisionally placing *crescentensis* Weaver and Palmer, 1922, in the synonymy of this species.

Description (from Schenck, 1926, p. 83)—"Shell small to medium, with a somewhat depressed spire, appressed sutures, body whorl with three tuberculous keels, outer lip strongly reflexed and lirate (in well-preserved specimens), inner lip forming a broad, rather thick callus free anteriorly. Sculpture: A smooth nuclear whorl followed by nepionic whorl characterized by axial riblets; in the next whorl,

vertical riblets more nodulous, and penultimate whorl distinguished by one row of distinct nodes axially elongate and with revolving threads becoming pronounced. Body whorl carrying three rows of nodes: uppermost row at shoulder of whorl and bears 8-12 nodes, depending upon thickness of callus; anterior to this keel is another well-developed row of nodes; between these two rows shell has beaded appearance, owing to intersecting of growth striae and spiral threads; immediately anterior to the two well-developed rows is a third, somewhat less developed but quite distinct, row with the low nodes axially offset from row above, with beaded appearance persisting, though not so markedly as between first two rows. Spire low, about one-third height of body whorl. Whorls about 5, at first sharply descending, but on the last whorl descent less abrupt, forming a shoulder that makes nearly a right angle with axis of coiling. Aperture ovate, rather narrow, with shallow posterior canal and drawn out anteriorly into comparatively long, recurved anterior canal. Inner lip callused, free anteriorly. Outer lip reflected and heavy, more lirate anteriorly than posteriorly."

Synonymy—

- 1864 Morio (*Sconsia*) *tuberculatus* Gabb, Geol. Surv. Calif. Paleo., vol. 1, p. 104, pl. 19, fig. 57 (Eocene, Martinez, California); 1894, Turner and Stanton, Amer. Geologist, vol. 14, p. 95 (New Idria); 1927, Stewart, Proc. Acad. Nat. Sci. Phila., for 1926, p. 380, pl. 28, fig. 11 (lectotype no. 4343, and complete synonymy).
- 1916 *Galeodea tuberculata* (Gabb), Dickerson, Univ. Calif. Publ. Geol., vol. 9, p. 433, pl. 42, fig. 2 (Domengine Creek).
- 1922 *Galeodea tuberculata* (Gabb) var. *crescentensis* Weaver and Palmer, Univ. Wash. Pub. Geol., vol. 1, no. 3, p. 36, pl. 11, figs. 18, 20 (Port Crescent, Glallam Co., Wash.; Eocene).
- 1924 *Galeodea tuberculiformis* Hanna, Proc. Calif. Acad. Sci., series 4, vol. 13, no. 10, p. 167. New name for *tuberculata* Gabb, not *Cassidaria tuberculata* Risso, 1826; 1926, Schenck, Univ. Calif. Publ. Bull. Geol. Sci., vol. 16, no. 4, p. 83, pl. 14, figs. 12-16; Vokes, 1939, Annals New York Acad., vol. 38, p. 149, pl. 19.
- 1942 *Coalingodea tuberculiformis* (Hanna), Durham, Jour. of Paleontology, vol. 16, no. 2, p. 186, pl. 29, fig. 9.

Subgenus *Hypocassis* Iredale, 1927Type: *Cassis fimbriata* Quoy and Gaimard, 1833

This subgenus differs little from true *Cassis*. The gutter posterior to the upturned siphonal canal is very shallow. The nuclear whorls of the shell of the type species are large and bulbous, but another Australian species, *nana*, has nuclear whorls intermediate in size. The lower columellar region in *fimbriata* is weakly toothed, but in *nana* it is strongly lirate, as in true *Cassis*. There are two living species, both limited to Australia. Iredale's generic description of *Hypocassis* does not differ from that of any other *Cassis*. *Nannocassis* Iredale, which I consider a synonym of *Hypocassis*, seems to be intermediate between *Cassis* and *Hypocassis*. It could be also synonymized with *Cassis*.

Synonymy—

1927 *Hypocassis* Iredale, Records Australian Museum, Sydney, vol. 15, p. 322, 329. (type by original designation: *Cassis bicarinata* var. *decrensensis* Hedley = *C. fimbriata* Quoy and Gaimard, 1833).

1927 *Nannocassis* Iredale, Records Australian Museum, Sydney, vol. 15, p. 322, 328. (type by original designation: *Cassis nana* Tenison-Woods, 1879).

***Cassis fimbriata* Quoy and Gaimard, 1833**

(Pl. 4, figs. 1-4; pl. 37)

Range—Within the Flindersian province of southern Australia from the Abrolhos Islands, Western Australia, to Portland, western Victoria.

Remarks—This handsome, medium-sized *Cassis* is moderately common throughout its limited range. It is characterized by its somewhat globose shape, the two rows of small nodules on the shoulder, the 5 to 7 former varices showing in the spire, and the fine, broken, spiral lines of chestnut-brown on the body whorl.

This shell is variable in several characters throughout its entire range, and, in my opinion, cannot be divided into geographical races nor be considered as two species in the process of hybridizing. The extreme forms led Hedley (1923, p. 46) to accept *C. fimbriata* Quoy and Gaimard and *C. bicarinata* Jonas as different

species. Iredale (1927, p. 329) kept them separate with reservations, but Cotton attempted to reinforce the differences by outlining four variants within *bicarinata*. Among the hundred specimens examined from 50 localities, I find gradual intergrades between these variants, but do not know if sexual dimorphism is responsible or not. The two most striking variants are:

- a) shell 2 to 3-1/2 inches in length; darkly colored with dark-brown maculations and axial zigzag bands; with two spiral rows of 12 to 15 rather large, sharp nodules; columella and inside of outer lip with very reduced teeth. (Pl. 4, figs. 3 and 4).
- b) shell 3 to 4 inches in length; somewhat elongate; reddish-brown to light brown in coloring; shoulder smooth except for faint crowded axial wrinkles; columella and inside of outer lip with strong teeth. (Pl. 37).

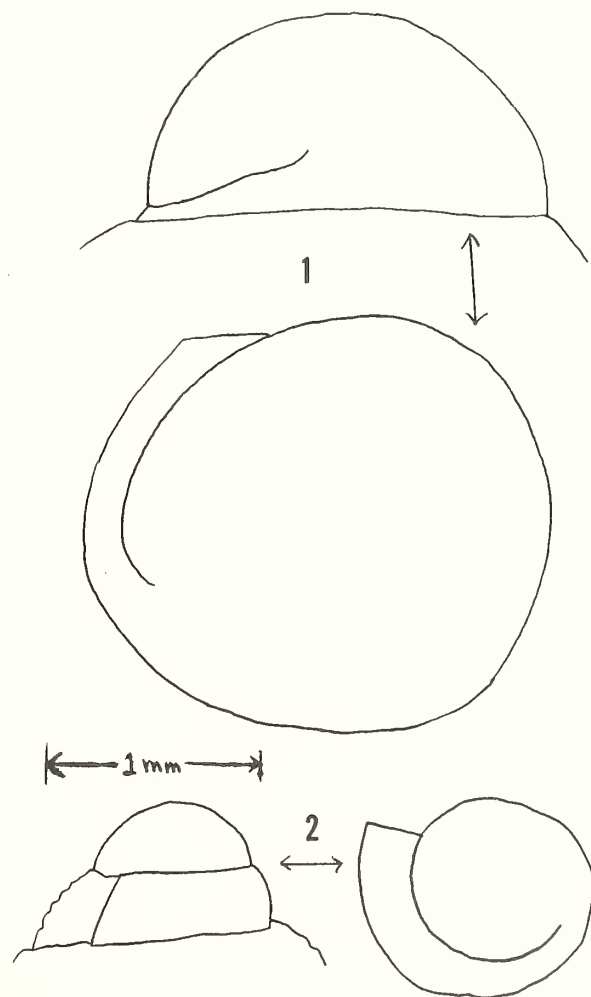


Plate 35. Nuclear whorls of *Cassis* (*Hypocassis*). Fig. 1, *fimbriata* Quoy and Gaimard. Fig. 2, *nana* Tenison-Woods.

The commonest form is illustrated in our Pl. 4, figs. 1 and 2. Curiously, the nuclear whorls may be moderately to greatly swollen in any of the variants, regardless of geographical origin. Hedley's form *decreasensis* appears to be between the commonest form and our form b mentioned above. The intensity of coloration varies somewhat from locality to locality, but is mainly due to the state of preservation and age of the shell. The height of spire varies widely with no geographical correlation. Some Western Australia specimens may have a beautiful pinkish mauve hue.

Habitat—From intertidal, sandy beaches to depths of 100 fathoms. Cotton (1945, p. 168) reports "45 living specimens being counted by me at high tide mark on Sellicks Beach in 1935." It has been dredged in moderately large numbers between 9 and 15 fathoms in Spencer and St. Vincent Gulfs.

Description—Adult shell about 76 to 128 mm. (3 to 5 inches) in length, globose, solid, shining, greenish to yellowish gray with axial maculations of chestnut-brown and with 8 to 12 broken spiral lines of dark brown. Whorls 6 to 7. Nuclear whorl usually swollen, bulbous, smooth, and yellow or white. Spire with an angle of 80 to 110 degrees and bearing 5 to 7 brown-blotched former varices, each one about 230 degrees of a complete turn from the other.

Suture irregularly and well-indented. Whorls in spire with numerous axial, wavy wrinkles which are commonly clumped in pairs. Last whorl with irregular, axial growth lines, giving

a peculiar shingling appearance. Spiral sculpture of 3 rows of 13 to 20 evenly-sized tubercles, the upper two rows at the shoulder being the strongest, the lowest row sometimes obsolete. Some variants lack tubercles and have a rounded, axially wrinkled shoulder. Umbilicus narrow but deep and bounded by the penultimate varix. Parietal shield moderately developed, usually reflected above so as to meet the suture above. Center of parietal shield thin with the coloring showing through. Base of shield whitish and with 4 or 5 short, oblique lirae. Columella cream to tan with 3 to 7 weak or rarely strong lirae. Inside of outer lip smooth or rarely (especially in young) with 14 or 15 weak denticles. Last varix reflected especially at the upper to middle third, glossy tan and with 5 to 7 broad bars of chestnut-brown. Base of outer shell with numerous, fine spiral threads. Interior of the recurved siphonal canal is brownish.

Operculum thin, chitinous, light-yellow, oblong, semi-concentric, and about $\frac{1}{4}$ the length of the aperture. According to Cotton (1945, p. 167), "the animal has a large foot which is white, round behind, uniformly but less curved in front; on its upper surface is a brown line about two millimeters broad, complete posteriorly where it is produced to the edge. The tentacles are short, pointed, white at the distal ends and at the proximal half. The eyes are placed halfway down on the outer side, and just beyond these for one-half of the part distal to them the colour is pink. The undersurface of the foot is quite white."

Measurements (mm.)—(spire height from last suture behind varix to apex)

length	width	spire height	spire angle (degrees)	no. whorls	no. varices	nodules on last whorl	
117	78	22	80	6	8	15	Cape Arid, Western Australia
105	78	14	110	6	8	16	off Cedune, South Australia
98	69	14	110	7	8	20	Portland, Victoria
94	65	17	100	6	8	20	Portland, Victoria
92	64	18	100	6	8	17	Glenelg, South Australia
90	55	22	80	7	8	too small	Glenelg, South Australia
87	55	19	100	6	7	too small	Glenelg, South Australia
77	55	15	90	6	7	13	Albany, Western Australia
68	46	12	100	6	7	too small	Albany, Western Australia
60	42	10	95	6	5	13	Glenelg, South Australia

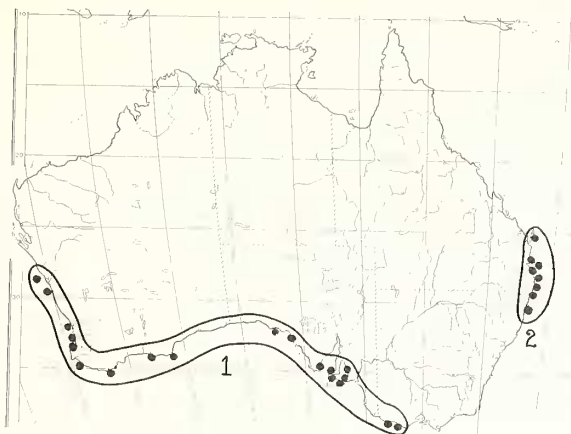


Plate 36. Geographical distribution of *Cassis* (*Hypocassis*). 1, *fimbriata* Quoy and Gaimard. 2, *nana* (Tenison-Woods).

Synonymy—

- 1826 *Cassis flammea* Lam., Gray, in King's Narrative Survey Coasts of Australia, vol. 2, appendix, p. 485, no. 60. Not Lamarck, nor Linné.
- 1833 *Cassis fimbriata* Quoy and Gaimard, in d'Urville's Voyage Astrolabe, Zoologie, vol. 2, p. 596, pl. 43, figs. 7, 8 (? îles Mariannes ou Carolines); 1835, Kiener, Coquilles Vivantes, vol. 8, Cassis, p. 12, pl. 4, fig. 6; 1848, Reeve, Conch. Iconica, vol. 5, pl. 7, fig. 17; 1923, Hedley, Records Australian Mus., vol. 14, no. 1, p. 47, pl. 8, fig. 2; 1927, Iredale, Records Australian Mus., vol. 15, p. 329.
- 1839 *Cassis bicarinata* Jonas, Archiv für Naturgeschichte, Berlin, 5th year, vol. 1, p. 343, pl. 10, fig. 2 (mare chinense); 1923, Hedley, Records Australian Mus., vol. 14, no. 1, p. 47, pl. 8, fig. 1; 1927, Iredale, *ibid.*, vol. 15, p. 330.
- 1923 *Cassis bicarinata* var. *decreseensis* Hedley, Records Australian Museum, vol. 14, no. 1, p. 47 (Kangaroo Island) refers to Kiener, 1835, pl. 4, fig. 6.
- 1927 *Hypocassis bicarinata* var. *decreseensis* Hedley, Records Australian Museum, vol. 15, p. 329, 330.
- 1927 *Hypocassis bicarinata* (Jonas), Iredale, Records Australian Mus., vol. 15, p. 320; 1945, Cotton, Trans. Royal Soc. South Australia, vol. 69, p. 167, text figs.; 1954, Cotton, Records South Australian Mus., vol. 11, no. 2 (animal and operculum fig'd.).
- 1927 *Hypocassis fimbriata* (Quoy and Gaimard), Iredale, *loc. cit.*, p. 319; 1945, Cotton, *supra cit.*, p. 168.

Types—I was unable to locate the type of *Cassis fimbriata*. The type locality of “?Îles Mariannes ou Carolines” is erroneous. Jonas' type of *bicarinata* is not in the Berlin Museum. Hedley (1923, p. 46) “restricted” the type locality of *fimbriata* to Albany, Western Australia. Cotton (1945, p. 167) restricted the type locality of *bicarinata* to the Gulf of St. Vincent, South Australia. The type locality of Hedley's variety *decreseensis* is Lacépède Bay, Kangaroo Island, South Australia. His type is in the Australian Museum in Sydney, no. C.30803.

Records—WESTERN AUSTRALIA: Abrolhos Islands (Miss Green, West. Aust. Mus.); Beagle Id. (Poole brothers, West. Aust. Mus.); Cottesloe beach, Perth; 9 fms. off Dunsborough, Geographe Bay (B. R. Wilson, West. Aust. Mus.); Bunbury (Cotton, 1945, p. 168); Duke of Orleans Bay (R. W. George, West. Aust. Mus.); 10 miles east of Cape Leeuwin (USNM); Albany and King George Sound (Nat. Mus. Vict.); Eucla (V. Wells, ANSP); Esperance; Eyres Sand Patch (both

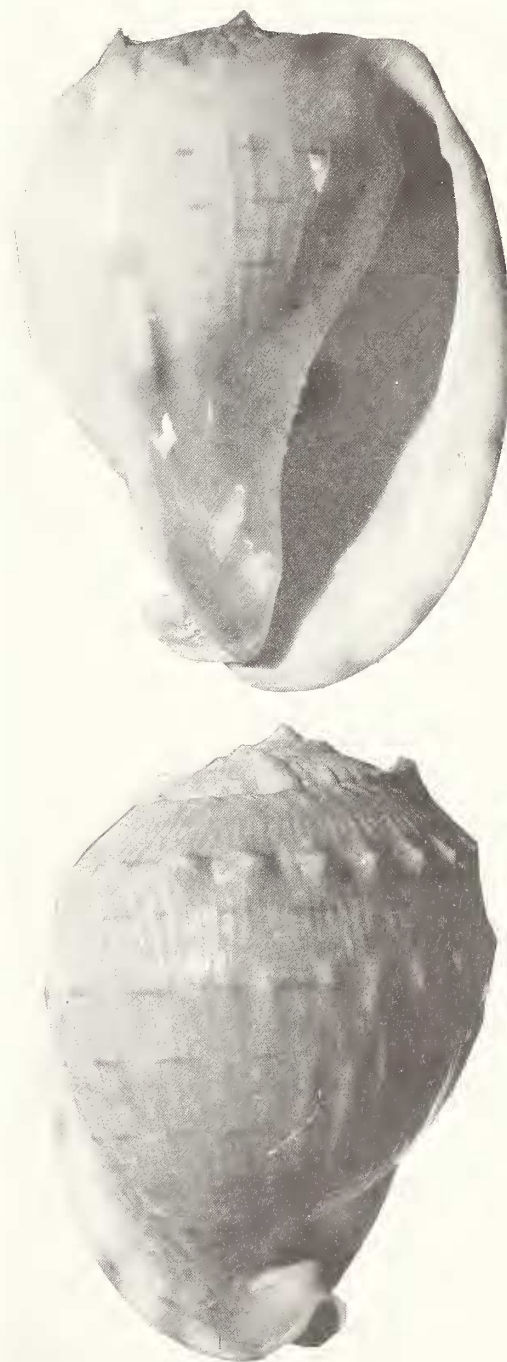


Plate 37. *Cassis* (*Hypocassis*) *fimbriata* Quoy and Gaimard, 1833. Holotype of *C. bicarinata decreseensis* Hedley. Off Kangaroo Island, South Australia. Australian Museum no. C. 30803.

Cotton, 1945, p. 168); Cape Arid (West. Aust. Mus.); SOUTH AUSTRALIA: off St. Francis Id., off Ceduna (T. Hartley, ANSP); Bolingbroke Pt., Boston Bay (Mrs. J. A. Grigg, ANSP); Investigator Straits, 15 fms.; Rapid Bay, 9 fms. (all Cotton, 1945, p. 167); Normanville, Gulf of St. Vincent (T. Hartley and J. A. Grigg, ANSP); Pine Pt., Yorke Peninsula (Nat. Mus. Vict.); Aldinga Bay, Gulf of St. Vincent (MCZ); Yankallilla Bay (Nat. Mus. Vict.); Semaphore and Glenelg, Adelaide (Nat. Mus. Vict. and ANSP). VICTORIA: Portland (Nat. Mus. Vict.); Port Fairy (Cotton, 1945, p. 168).

Fossil records—None known to me.

Cassis exigua Tenison-Woods, 1879

(Pl. 38)

Range—Oligocene or Miocene, Muddy Creek, Victoria, Australia.

Remarks—This species is extremely close to the Recent South Australian *C. fimbriata* Quoy and Gaimard, differing only in having a fourth, lower, spiral row of nodules on the body whorl. The type specimen is young, and in 1889 Tate further illustrated and described adult specimens:

"Shell stout, oblong-ovate, ventricose, with a very short conic spire, ending in a small pullus [nucleus] of one and a half smooth swollen turns, with the tip reverted and immersed. Whorls five, excluding pullus, variced at successive intervals of about two-thirds of a whorl, the first whorl transversely corrugate and spirally striate; sutures granulosely marginate.

"Last whorl with a very high back, somewhat precipitous over the suture; bearing on the angle a row of 12 compressed sharp-pointed tubercles, and on the medial portion two other rows equidistantly placed, but of smaller size, a fourth inconspicuous row is developed on the adult shell. Base somewhat cancellated.

"Aperture narrow, sinuously curved at each end; outer lip flattened, inflected, and slightly reflected, plicately dentate. Inner lip widely spreading, projecting behind as a thin plate, and terminated by the varix, over which it projects. Columella strongly dentately wrinkled throughout, as well as the anterior portion of the callous-covering. Length, 40; breadth of last whorl, 30; height, 27; length of aperture, 37; but attains to a length of 52."

Synonymy—

1879 *Cassis exigua* Tenison-Woods, Proc. Linn. Soc. New South Wales, vol. 4, p. 17, pl. 2, fig. 7 ("Lower beds of Muddy River"); 1889, Tate, Trans. and Proc. Royal Soc. South Australia, vol. 11, p. 164, pl. 7, fig. 13; 1896, Harris, Cat. Tertiary Mollusca, pt. 1, p. 197; 1935, Davies, Tertiary Faunas, London, vol. 1, p. 271, fig. 387 (Balcombian, Muddy Creek, Victoria).

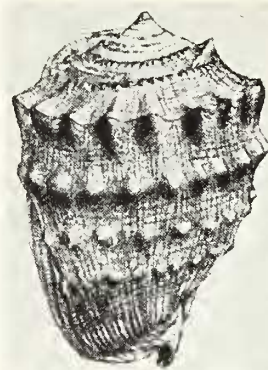


Plate 38. *Cassis (Hypocassis) exigua* Tenison-Woods, 1879. Lower Beds of Muddy Creek, Victoria, Australia. Tertiary. Length: 40 mm. (from Tate, 1889, pl. 7, fig. 13).

Cassis salisburyensis Ludbrook, 1958

Range—Pliocene of Adelaide, South Australia.

Remarks—(from Ludbrook's original) "A small, [42 × 30 mm.] stout *Hypocassis* moderately ventricose with a short spire. Body whorl with 10 prominent tubercles, on the posterior angle of the whorl, decreasing in number and prominence in a second and third row of tubercles at the middle of the whorl. Outer lip denticulate. This species is intermediate between *C. textilis* Tate and *C. exigua* Tenison-Woods. It differs from *exigua* in being less strongly sculptured on the spire and in having 3 rows of less numerous tubercles. It differs from *textilis* in having 10 instead of nine tubercles on the body whorl and in being less inflated, with a lower spire. It is a much smaller and thicker shell than *C. fimbriata* Quoy. I believe it might be a subspecies of the Recent *fimbriata* Quoy and Gaimard, and possibly a synonym of *exigua*.

Synonymy—

1958 *Cassis (Hypocassis) salisburyensis* Ludbrook, Transactions Royal Society South Australia, vol. 81, p. 51, pl. 2, figs. 1, 2. (Tennant's Bore, Salisbury; Pliocene of the Adelaide Plains, South Australia).

Cassis nana Tenison-Woods, 1879

(pl. 4, figs. 5, 6; pl. 39)

Range—Eastern Australia.

Remarks— This very attractive species is the smallest living *Cassis*. Adults are only 1 to 2-1/4 inches in length, and are characterized by two spiral rows of rounded knobs on the shoulder, by the spot-less, flattened varix, by the sealed umbilicus and by the absence of axial wrinkles on the top of the whorls in the spire. The latter feature readily distinguishes *nana* from the young of *Cassis cornuta* Linné and *C. fimbriata* Quoy and Gaimard. In some specimens of *nana*, a third, fourth and rarely fifth spiral row of very subdued nodules may be present.

Habitat—Locally it is moderately common on sand bottoms at depths of 30 to 120 fathoms. It is uncommon in collections.

Description—Adult shell 30 to 58 mm. (1-1/4 to 2-1/4 inches) in length, solid, rotund, with 2 spiral rows of about 8 to 11 even-sized, small

knobs on the shoulder of the dorsum; with a thin, sharp-edged parietal shield and with a well- but finely-toothed inner and outer lip; and taffy-brown in color. Nuclear whorls only 1-1/2, small but bulbous, smooth and ivory-yellow. Post-nuclear whorls 6, with weak spiral striae which disappear after the third or fourth whorl. Suture finely impressed, wavy, and bounded on both sides by weak, tiny knobs. Last whorl with 3, rarely 4, spiral, low cords, the upper two bearing 8 to 11 small knobs on the shoulder of the dorsum. Varices 5 to 6. Parietal shield broad, but thin, and with a thin, sharp edge. Columella with numerous, fine, short, white, spiral plicae. A channellike, smooth depression in the middle gives a gnarled appearance to the inner lip. Glossy, whitish, broad outer lip is bounded on its inner edge by about 14 small denticles. Aperture narrow; white within. Body whorl tan with 4 or 5 narrow, spiral bands of alternating blotches of darker tan and white. Surface with microscopic, axial scratches which give a "silky" or "watery" effect. Siphonal canal short, recurved toward the left. Umbilicus usually sealed by an extension of the posterior side of the parietal shield. False umbilicus usually sealed. Operculum and animal unknown.

Measurements (mm.)—

length width no. whorls

58.0	43.5	7	large; off Brisbane, Queensland
42.0	33.2	6	average; Southport, Queensland
41.2	33.0	6	average; Southport, Queensland
34.5	26.1	6	small; off Moreton Id., Queensland
33.5	28.0	-	holotype? Nat. Mus. Vict. no. F666
25.0	17.0	6	holotype (fide Tenison-Woods)

Synonymy—

1879 *Cassis nana* Tenison-Woods, Proc. Linn. Soc. New South Wales, vol. 4, p. 108, Moreton Island, [Brisbane, Queensland, Australia]; 1899, Hedley, *ibid.*, vol. 24, p. 434, fig. 6; 1934, Wrigley, Proc. Mal. Soc. London, vol. 21, p. 109.

1927 *Nannocassis nana* (Tenison-Woods), Iredale, Records Australian Mus., vol. 15, p. 328; 1959, Allan, Australian Shells, revised ed., Georgian House, p. 119, text fig. 26-9.

Types—The type locality is Moreton Island, near Brisbane, Queensland, Australia. According to Hedley, 1899, p. 434, the holotype collected by Mr. C. Coxen is in the Queensland Museum.

Records—All Australia: QUEENSLAND: beach at Frazer Id. (Joy Kerslake, ANSP); Noosa Heads (Joy Kerslake, ANSP); trawled off Caloundra (Joy Kerslake, ANSP); 120 fms. off Moreton Id., Brisbane (A. R. Whitworth, ANSP); 30 fms.,

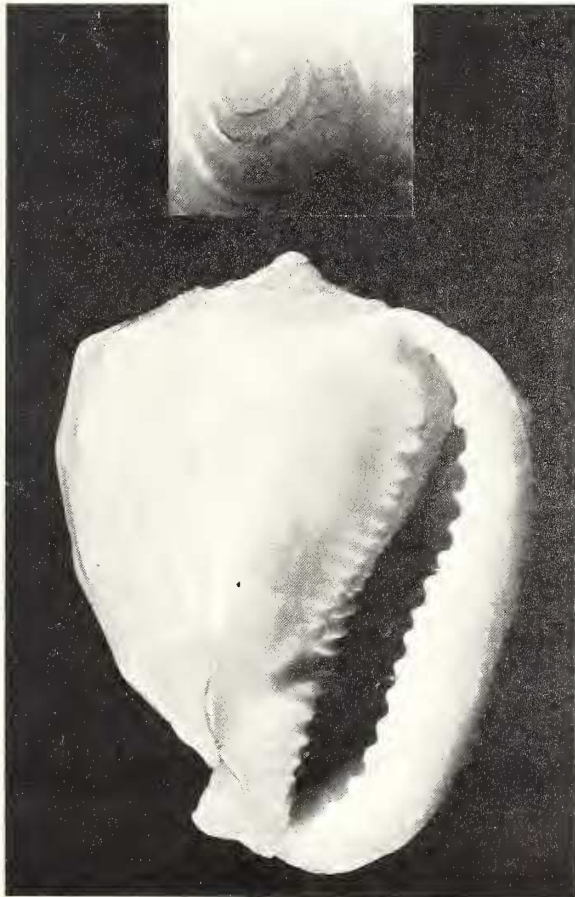


Plate 39. *Cassis (Hypocassis) nana* Tenison-Woods, 1879. Holotype no. F 666, National Museum of Victoria, Queensland, Australia. 33 mm. Enlarged nuclear whorls are from a Caloundra specimen.

off Southport (T. A. Garrard and T. C. Marshall, ANSP; MCZ); 28 fms. off Coolumb, Brisbane (A. Bannah, ANSP). NEW SOUTH WALES: mouth of the Richmond River, Ballina, (Hedley, 1899, p. 434); off Evans Head (Val Manks, AMNH); Nambucca and Trial Bay (both Aust. Mus.).

Fossil records—None reported.

Cassis torva (Iredale, 1927)

(Pl. 40)

Range—Tertiary of Queensland, Australia.

Remarks—This is a very distinct fossil species which shows a closer resemblance to *Cassis fimbriata* than to the small *nana*. The holotype in the Australian Museum (C. 53259) is 57 (not 67) mm. in length and 38 mm. in width. Mrs. L. M. Currey possesses a specimen from Caloundra. It is 45 mm. in length.

Synonymy—

1927 *Nannocassis torva* Iredale, Records Australian Mus., Sydney, vol. 15, p. 329 (Caloundra, South Queensland), brief mention only; 1927, The Australian Zoologist, Sydney, vol. 4, p. 335, pl. 46, fig. 7.



Plate 40. *Cassis (Hypocassis) torva* (Iredale, 1927). Holotype from Tertiary of Caloundra, Queensland, Australia. Australian Museum no. C. 53259.

Cassis textilis Tate, 1882

(Pl. 41)

Range—Oligocene of Victoria, Australia.

Remarks—I have not seen specimens of this species, but from the description of the small, sub-globose nucleus and the shape of the rather flattened siphonal canal, I am inclined to ally it to the Recent *nana* Tenison-Woods of Queensland and also to *fimbriata* Quoy and Gaimard of the southern coasts of Australia. The last whorl bears spiral threads as well as three rows of tubercles. The original description reads:

“Shell stout, ovate, ventricose, with a short conic spire ending in a small sub-globose pullus, [nucleus] the tip reverted and immersed. Whorls five, excluding pullus, with varices at successive intervals of about two-thirds of a whorl, ornamented with numerous spiral threads crossed by folds of growth, wrinkled at the suture. Last whorl bearing on the superior angle a row of nine nodular tubercles, and on the medial portion two other rows equi-distantly placed, the tubercles of which are smaller, much more so are those of the anterior row. Posterior area concavely sloping backward to the suture.

“Outer lip thickened, margin plain. Columellar callus dentate; columella very tortuous beneath the callus, canal recurved. Length, 45; breadth of last whorl, 32; height, 29; length of aperture, 31 mm.”

Synonymy—

1882 *Cassis textile* Tate, Trans. and Proc. Royal Soc. South Australia, vol. 5, p. 45; 1889, Tate, *loc. cit.*, vol. 11, p. 165, pl. 7, fig. 11 (River Murray cliffs near Morgan; Cheltenham, Port Philip Bay).
1903 *Cassis textilis* Tate, Cossmann, Essais de Paléoconchologie Comparée, vol. 5, p. 125 (Oligocene).



Plate 41. *Cassis (Hypocassis) textilis* Tate, 1882. Oligocene of Victoria, Australia. Length: 45 mm. (from Tate, 1889, pl. 7, fig. 11).

Genus *Cypraeacassis* Stutchbury, 1837

The four living species in this genus are characterized by oblong, rather heavy shells, with predominantly orange and chocolate-brown pigmentation, numerous fine teeth on the columella, absence of former varices, and a large, translucent apex of 4 or 5 bulimoid whorls. The soft parts are usually orange in color. The operculum is very small, paucispiral, oval, and may be lost in adults. The eyes are located on the tentacles, about $\frac{1}{3}$ from the base. The tentacles have a small, circular black pigment ring near the distal end.

The subgenus *Leventia* of dubious value was erected by Gray for the species *coarctata* Gray. It differs only in having the upper part of the outer lip reflected inwardly.

Subgenus *Cypraeacassis* Stutchbury, 1837

Type: *Cypraeacassis rufa* Linné, 1758

There are only three living species in the typical subgenus. The smallest species, *C. testiculus* (Linné) is common to both sides of the tropical Atlantic, and is evidently a survivor of an abundant line of similar *Cypraeacassis* from the Miocene and Pliocene of the Mediterranean area. The *C. tenuis* (Wood) of the Eastern Pacific is possibly an offshoot of the Indo-Pacific *C. rufa* (Linné), probably during the early Pleistocene. The latter species has Miocene relatives in East Africa.

Synonymy —

1837 *Cypraeacassis* Stutchbury, Magazine Natural History (Charlesworth), new series, vol. 1, p. 214 (type by original designation: *Buccinum rufum* Linn.).

1903 *Cypraeicassis* Cossmann, Essais de Paléoconchologie Comparée, Paris, vol. 5, p. 129. Emendation for *Cypraeacassis* Stutchbury, 1837.

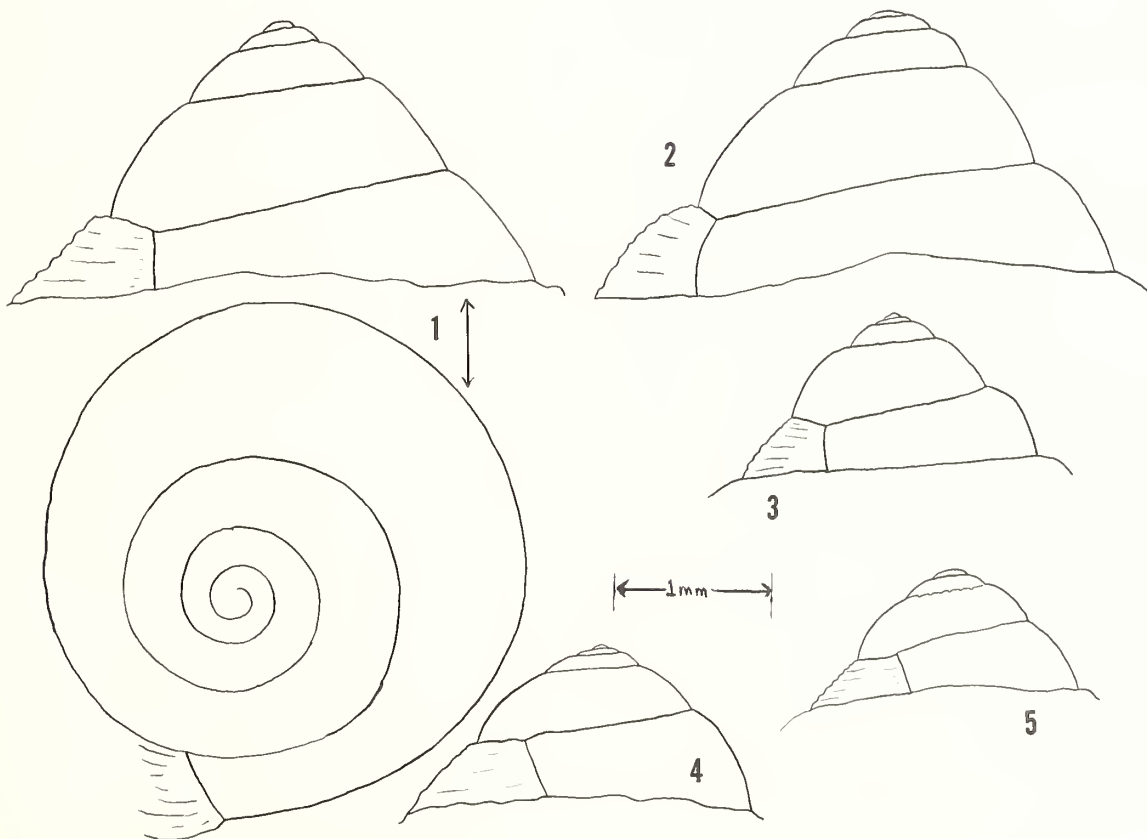


Plate 42. Nuclear whorls of *Cypraeacassis*. Fig. 1, *rufa* (Linné). 2, *tenuis* (Wood). 3, *coarctata* (Sowerby). 4, *testiculus*

(Linné) from the Miocene of Santo Domingo. 5, *testiculus* (Linné) from the Recent of Brazil.



Plate 43. World distribution of the species of *Cypraeccassis*.
1, *rufa* (Linné); 2, *tenuis* (Wood); 3, *coarctata* (Sowerby);

4, *testiculus testiculus* (Linné); 4a, *testiculus* subspecies
senegalica (Gmelin).

Cypraeacassis rufa (Linne, 1758)

(Pl. 3, fig. 10; pl. 4, figs. 10-12; pls. 44-46)

Range—East Africa to eastern Polynesia.

Remarks—This well-known species has a wide distribution but is abundant only at the extreme ends of its range, in East Africa and the Line Islands of eastern Polynesia. It is rare in some central areas, such as the Ryukyu Islands, the Philippines, Indonesia and northeastern Australia. It would appear that it is dying out in the middle of its range. In central East Africa it is collected in large numbers and shipped to Italy where cameos are made from the shell. It is the only living Indo-Pacific species in the genus *Cypraeacassis*. Its nearest relative is *C. tenuis* (Wood, 1828) of the tropical Eastern Pacific.

Mr. John F. Spry of Tanganyika writes me that *rufa* apparently preys on the local short-spined sea urchins.

Habitat—*C. rufa* is a shallow water species living from the intertidal area to a depth of about 6 feet below low tide mark. It generally lives in fairly sheltered areas where the bottom is of coarse coral sand and algae near coral reef areas.

Description—Adult shell 64 to 185 mm. (2-1/2 to 7-1/2 inches) in length, ovate, solid, usually heavy, with 3 or 4 rows of rounded knobs on the dorsum, and with a glossy, orange and brownish red parietal area. Nuclear whorls 5, bulimoid, smoothish, set at an angle of about 20 degrees off the axis of the adult shell; with the first 3 whorls colored whitish tan and the last two reddish brown. The last nuclear whorl has a minute varix. First 3 or 4 post-nuclear whorls with numerous, crowded, fine, irregular spiral threads and cords which become larger and coarser in the last whorl. No former varices in the spire. Body whorl with 3 spiral rows of 6 to 9 fairly large round low, smoothish knobs. Below these is one row of 8 to 12 smaller, axially elongated plicae, and, at the base of the whorl, are 2 rows

of 10 to 14 long, narrow, white, raised bars. Between the spiral rows of knobs there are 2 to 3 spiral cords bearing very small, wart-like, numerous beads. Color of shell reddish or orange-brown with white or grayish pink maculations. Outer lip thin or very thick, glossy, and colored cream and with 7 to 9 broad or paired bars of darker orange-brown. Inside of outer lip with 14 to 21 short or long, raised, white teeth. Parietal wall heavily glazed, rounded, with 5 diffused, broad bands of darker orange-brown. Inner lip with numerous, fine, long, spiral, whitish lirae over a dark-brown patch. Within the aperture and on the columellar wall is an axial swelling bearing 5 to 12 larger whitish teeth. True umbilicus narrow but deep; false umbilicus slightly open or nearly sealed. Operculum chitinous, oval, thick, with concentric growth lines, and proportionately very small (about one tenth the length of the aperture).

Measurements (mm.)—

length	width	no. whorls	
185.0	135.0	8	large; Madagascar
161.0	126.0	8	large; Zanzibar
125.0	95.0	9	average; Chagos Archip.
64.0	43.5	8	small; Moluccas

Synonymy—

- 1758 *Buccinum rufum* Linné, Systema naturae, ed. 10, p. 736, no. 385 (in Oceano Americano [erroneous]). Refers to Rumphius, pl. 23, fig. B; Gualtieri, pl. 40, fig. F; and others; 1767, Linné, ed. 12, p. 1198, no. 446; 1956, Dodge, Bull. Amer. Mus. Nat. Hist., vol. 111, pp. 177-178.
- 1778 *Buccinum pullum* Born, Test. Mus. Caes. Vindob., p. 236; refers to Lister, pl. 1007, fig. 71.
- [1786 *Cassides chartoprates* Meuschen, Mus. Geversianum, Rotterdam, p. 394, nos. 1299-1301. Non-binomial].
- 1791 *Buccinum ventricosum* Gmelin, Systema naturae, ed. 13, p. 3476, no. 25 (no locality); refers to Lister, pl. 1007, fig. 71, a young specimen.



Plate 44. Operculum of *Cypraeacassis rufa* (Linné). Mahé, Seychelles. R. Winekworth, coll. Shell, 152 mm.; operculum 8.2 mm. Left: outer side; right: inner, attachment side.

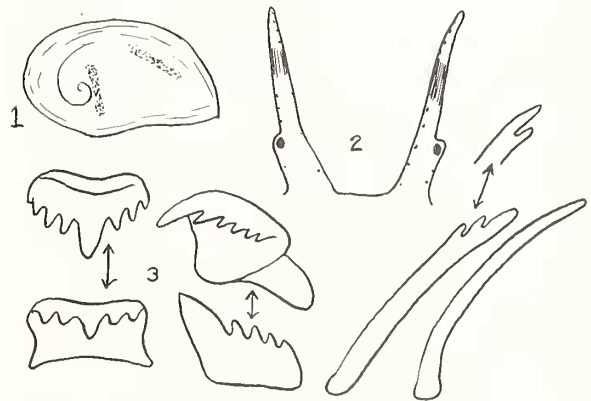


Plate 45. *Cypraeacassis rufa* (Linné), young male from Zanzibar. Fig. 1, attachment side of operculum, 4 mm. in length. Fig. 2, tentacles. Fig. 3, various views of radular teeth, showing variation in the number of denticles.

- 1791 *Buccinum pennatum* Gmelin, loc. cit., p. 3476, no. 21 (in India); refers to Rumphius, pl. 23, fig. C, and Conchyl.-Cab., vol. 2, figs. 372, 373, a young specimen.
- 1792 *Cassidea pennata* Bruguière, Encyclop. Méthodique, Vers, vol. 1, no. 2, p. 427, no. 11 (Amboina); refers to Lister, pl. 1007, fig. 71; and others.
- 1792 *Cassidea rufa* Linné, Bruguière, loc. cit., p. 433, no. 16.
- [1797 *Cassida os-tauri* Humphrey, Museum Calonnianum, p. 19. Non-binomial].
- 1798 *Cassis rufum* Gmelin, Röding, Mus. Boltinianum, Hamburg, pt. 2, p. 28, no. 349 (no locality); refers to Conchyl.-Cab., vol. 2, fig. 341 and Knorr, pt. 2, pl. 9, fig. 2.
- 1798 *Cassis rufescens* Röding, loc. cit., p. 29, no. 350 (no locality).
- 1798 *Cassis pennata* Gmelin, Röding, loc. cit., p. 29, no. 359 (no locality).
- 1798 *Cassis tuberosa* Röding, loc. cit., p. 28, no. 343 (in part by referring to Knorr, pt. 6, pl. 18, fig. 1; non Linné, 1758).
- 1811 *Cassis labiata* Perry, Conchology, London, Appendix, pl. 33, no. 4 (Cape of Good Hope and African Seas). Not *Cassidea labiata* Perry, 1811.
- 1822 *Cassis rufa* Linné, Lamarck, Anim. sans Vert., vol. 7, p. 224, no. 13; 1835, Kiener, Coq. Vivantes, Paris, vol. 8, Cassidaire, pl. 7, figs. 12, 13.
- 1837 *Cypracassis rufa* Linné, Stutchbury, Mag. Nat. Hist. (Charlesworth), vol. 1, p. 214, figs. 22a, b; 1927, Iredale, Records Australian Museum, vol. 15, p. 330.
- 1935 *Cassis (Cypracassis) rufa* Linné, Bayer, Zoologische Mededeelingen, Leiden, vol. 18, p. 96.

Types—There is a specimen of this well-known species in the Linnaean collection in London which may be the type. Linné's type locality of "In Oceano Americano" is erroneous. We designate Amboina, Indonesia, as the type locality.

Nomenclature—Although seven other names have been given to this species, the identity and use of the name *rufa* has been unanimous among workers since Deshayes' (1835) time. The young form was thought to be another species (*pennata* Gmelin and *pulla* Born) by some early workers, such as Bruguière.

Records—SOUTH AFRICA: 10 to 20 feet, off Durban, Natal (P. Elston, *in litt.*, 1962); north Zululand coast (Helen Boswell, *in litt.*, 1962). MOZAMBIQUE: Lourenco Marques (P. Elston, *in litt.*, 1962); Bazaruto Bay (MCZ); Port Amelia (USNM). TANGANYIKA: Sinda Id., off Dar-es-Salaam (R. T. Abbott, USNM); Fungi Yasin; Ras Kankodya; Oyster Bay; Kendiva (all John F. Spry, *in litt.*, 1962). KENYA: Malindi (USNM); Diani Beach, 20 mi. south of Mombasa (R. T. Abbott, USNM). ZANZIBAR: reef flat at Ras Nungwe; 2 mi. north of Kizimkazi; Mnemba Id. (all A. J. Ostheimer, 3rd, ANSP). SOMALIA: 50 mi. north of Obbia (AMNH). MADAGASCAR: Madirokely, Nossi-bé (Madame Caille, ANSP); Nosy Sakatia, Nossi-bé (ANSP Exped., 1960); Ambodifolotra, Ile Ste. Marie (R. W. Foster, MCZ); Tuléar (Dautzenberg coll'n., Bruxelles); Mayote Id., Comores (Rijksmus. Leiden). INDIAN OCEAN ISLANDS: Gloriosa Id. (USNM). SEYCHELLES: Mahé (R. Winckworth, BM); Peros Banhos Id., Chagos Archip. (Mauritius Inst.; ANSP); Salomon, Chagos Archip. (Mrs. J. Couacaud, ANSP). MAURITIUS: Arsenel (Mr. J. Couacaud, ANSP); Port Louis (MCZ); Rodriguez (P. Elston, *in litt.*, 1962). MALDIVES: Dandru, Suva Diva (A. Agassiz, MCZ); Nadale Id., Suva Diva (USNM); Hulule Id. (E. A. Smith, 1903, p. 611); Imma Id., North Malé Atoll (R. Robertson, 1964, Inter. Indian Ocean Exped.). COCOS-KEELING: (Gibson-Hill, USNM and Raffles Mus.). INDONESIA: Nias Id., Sumatra; Poeloe Pandjung; Medan; Tjilatjap, Java; Poeloe Tello, Batoe Id.; Amboina; Timor Id.; Waigeo Id. (all Rijksmus. Leiden); South Loloda Ids., west of Halmahera (D. Fairchild, MCZ); Ceram Id. (MCZ); Kangean Id. (Mus. Zool. Bogoriense, fide Butot, *in litt.*). NEW GUINEA: Korido Bay, Soepiori, Schouten Ids. (A. J. Ostheimer, 3rd, ANSP); Mopia; Ile Manasbari (both Dautzenberg coll'n., Bruxelles). BISMARCKS: Kaliai Reef, New Britain Id. (H. Coutourmas, ANSP). AUSTRALIA: Thursday Id. (Geo. Pattison, *in litt.* 1962). RYUKYUS: Okinawa (R. T. Abbott, 1958, ANSP). FORMOSA: Hoko (Kuroda, 1941, p. 104). PHILIPPINES: Siasi Id., Sulu Archip. (USNM). SOLOMONS: Ususue, Ata, Malaita Id. (Rev. J. van der Riet, ANSP); Senga, Choiseul Id. (W. Eyerdam, 1929, AMNH); Vanikoro Id., Santa Cruz Ids. (Aust. Mus.). PALAUS: Pelelieu Id. (A. J. Ostheimer, 3rd, ANSP). FIJI: ?(Nat. Mus. Victoria). TOKELAU: Swain Id., north of Samoa (ANSP). TUAMOTUS: Disappointment Id. (Titian R. Peale, 1834, U.S. Expl. Exped., ANSP); Manahi Id. (J. M. Clements, USNM); Raroia (J. P. E. Morrison, USNM). GILBERT ISLANDS: (B. P. Bish. Mus.). LINE ISLANDS: Baker Id.; Washington Id.; Jarvis Id. (all B. P. Bishop Mus.); Caroline Id. (C. D. Voy, ANSP).

Fossil records—None known to me.

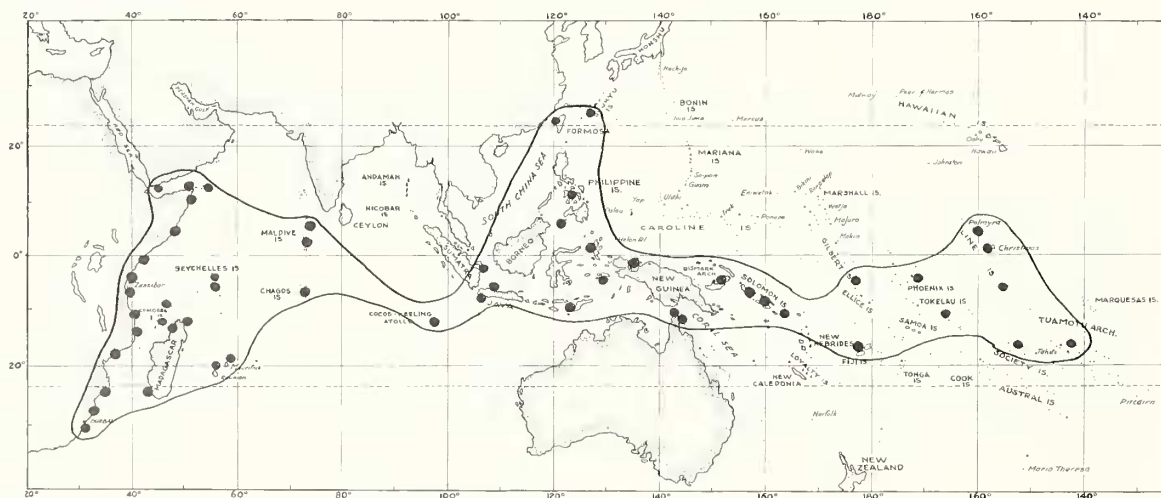


Plate 46. Geographical distribution of *Cypracassis rufa* (Linné).

Cypraeacassis pustulata (Cox, 1927)

(Pl. 47, figs. 4-6)

Range—Miocene of Pemba Island, East Africa.*Remarks*—This and *C. morus* Cox from the same locality are probably forms of the same species. They show some resemblance to the Recent *Cypraeacassis rufa* Linné.*Synonymy*—1927 *Cassis* (*Cypraeacassis*) *pustulata* Cox, Report on the Palaeontology of the Zanzibar Protectorate, p. 26, pl. 9, figs. 11a, b. (Pemba station 68).1927 *Cassis* (*Cypraeacassis*?) *morus* Cox, *loc. cit.*, p. 27, pl. 9, figs. 10a, b. (Pemba station 68).**Cypraeacassis testiculus (Linné, 1758)**

Today, this species is living in tropical Atlantic waters both in the Eastern and Western Atlantic. Pliocene representatives from Italy, such as *Cypraeacassis cypraeiformis* (Borson, 1820) and *C. pseudocrumena* (Orbigny, 1852) are similar but certainly not conspecific with the living *testiculus*. However, Miocene specimens from the West Indies (Santo Domingo, Wm. Gabb, 1873) are almost inseparable from today's *testiculus*, which suggests that the original stock of *testiculus* was American. In Europe there are many Pliocene forms, some of which closely resemble the extremely plicate form "*crumena*"

of the Recent West African, Cape Verde, Ascension, and St. Helena Islands. The extreme variation in the Recent Eastern Atlantic colonies seem to have been contributed by European Pliocene and Pleistocene stocks.

Unfortunately, the Recent *testiculus* from the Eastern and Western Atlantic are not clearly separable, and this state is evident from the way former workers have treated this taxon. Bayer (1935) and Salmon (1948) considered them different species; Clench and Abbott (1943) considered them the same and reduced "*crumena*" to the status of a forma. I have since examined numerous specimens from both sides of the Atlantic, and now believe they should be treated as subspecies. It should be pointed out that although many West African specimens are characteristically large, devoid of spiral sculpturing, and with very large smooth, axial plications, one may find in the same colonies specimens which are identical to West Indian forms. Certain Caribbean specimens may have similar but much smaller plicae. My subspecies separation is admittedly weak, although a practical one. The earliest name for the Eastern Atlantic subspecies is *senegalica* (Gmelin, 1791) with *crumena* (Bruguière, 1792) a synonym. If one were to apply a name to the weakly plicate Caribbean form, the earliest name is *bicincta* (Bayer, 1935). *Cassis mitella polonica* Röding, 1798, is a synonym of *testiculus* Linné.

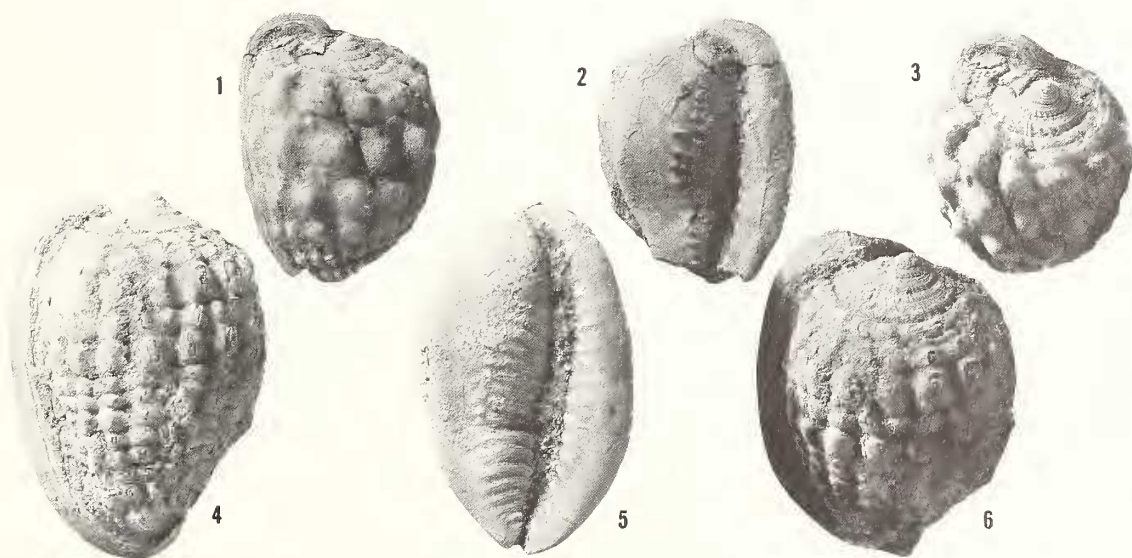


Plate 47. Miocene *Cypraeacassis* from Pemba Island, East Africa. Figs. 1-3, holotype of *C. morus* (Cox, 1927). 36 mm. Figs. 4-6, holotype of *C. pustulata* (Cox, 1927). 50 mm. All

photos courtesy of T. Nuttall, British Museum (Natural History).

Cypraeacassis testiculus
subspecies testiculus (Linné, 1758)
 (Pl. 4, fig. 9; pl. 48)

Range—Bermuda, southeast Florida, the Caribbean and south to Brazil. Tertiary of the Caribbean.

Remarks—This is a moderately common shallow-water species ranging in size from 1 to 3-1/4 inches, and characterized by 13 to 17 spiral rows of numerous, small, usually elongate beads or short, axial plicae, and by a heavily glazed, low, rounded parietal shield. The latter is white above and with orange stain on the lower third. The shell is usually brightly colored with orange-brown maculations, zigzag stripes or rows of arrow-shaped spots.

Clench and Abbott, (1943, p. 2), report that *testiculus* in the West Indies "is found usually around reef water where it can migrate from the deeper water to lay its eggs in the warmer and shallower regions. The eggs are the size of swollen grains of rice and are laid under small rocks or under large broken shells in greenish brown clusters of a hundred or so capsules."

I have revised and added to the synonymy of this species and its Eastern Atlantic subspecies *senegalica* (Gmelin, 1791). Clench and Abbott (1943) used the younger name, *crumena* (Bruguère, 1792).

In the fossil state, *C. testiculus* occurs in the Pleistocene of Barbados and Cuba, and, according to Gabb, Maury and Pilsbry, in the Miocene of the Dominican Republic (Weisbord, 1962, p. 254).

Types—Linnaeus' type, according to Dodge (1956, p. 182) is in the Linnaean Society collection in London. The type locality is Jamaica, British West Indies.

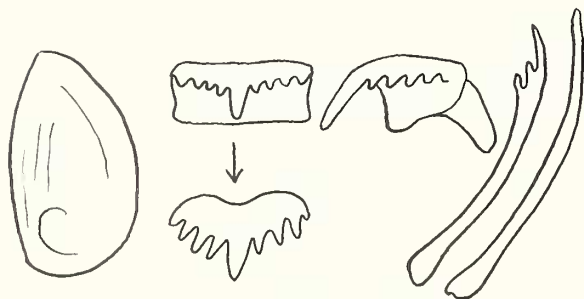


Plate 48. *Cypraeacassis testiculus* (Linné). Operculum from young specimen, and radulae from adult female from Yuma, Haiti.

Synonymy—

- 1758 *Buccinum testiculus* Linné, Systema naturae, ed. 10, p. 736, no. 387 (Ad Jamaican); refers to Rumphius, pl. 23, fig. 3; Gualtieri, pl. 39, fig. C. (selected type figure by Clench and Abbott, 1943, p. 2); 1767, Linné, ed. 12, p. 1199, no. 449; 1956, Dodge, Bull. Amer. Mus. Nat. Hist., vol. 111, pp. 181-182.
- 1798 *Cassis pileolus* Röding, Mus. Boltenianum, Hamburg, pt. 2, p. 29, no. 356 (no locality); refers to Conchyl.-Cab., vol. 2, figs. 375, 376; Knorr, pt. 4, pl. 6, fig. 1.
- 1837 *Cypraeacassis testiculus* Brug., Stutchbury, Mag. of Nat. Hist. (Charlesworth ed.), new series, vol. 1, p. 216, 472, fig. 53.
- 1917 *Cassis (Cypraeacassis) testiculus* (Linnaeus), Maury, Bull. Amer. Paleont., vol. 5, no. 29, p. 275, 1922, Maury, loc. cit., vol. 9, no. 38, p. 118; 1935, Bayer, Zoolog. Mededeel., vol. 18, p. 97.
- 1935 *Cassis testiculus* var. *bicincta* Bayer, Zoologische Mededeel., Leiden, vol. 18, p. 97, fig. 1.
- 1943 *Cypraeacassis testiculus* Linné, Clench and Abbott, Johnsonia, vol. 1, no. 9, pp. 1-3, pl. 1, pl. 3, figs. 1-3; 1961, Warmke and Abbott, Caribbean Seashells, Livingston Co., Narberth, Pa., p. 99, pl. 3, fig. C, p. 320 (distribution map); 1962, Weisbord, Bull. Amer. Paleont., vol. 42, pp. 252-254, pl. 23, figs. 11-14.

Cypraeacassis testiculus
subspecies senegalica (Gmelin, 1791)
 (Pl. 50)

Range—West coast of Africa from Senegal to Angola, and the offshore islands of Cape Verde, Ascension and St. Helena.

Remarks—Some few specimens are very similar to the typical *testiculus* from the Caribbean, but most are larger (3 to 4 inches in length),



Plate 49. Geographical distribution of *Cypraeacassis testiculus testiculus* (Linné) in the Western Atlantic (1) and *testiculus* subspecies *senegalica* (Gmelin) in the Eastern Atlantic (2).

smoother, a duller color, and bear 5 to 7 quite large, smooth, axial plications on the shoulder of the last whorl. It is very variable in sculpture.

Measurements (mm.)—

length	width	no. whorls	
97.0	62.0	7+	large; St. Helena
93.9	57.2	7+	type of <i>crumena</i> Brug.
90.5	54.8	8+	large; St. Helena
82.8	51.3	7+	average; St. Helena

Synonymy—

- [1757 *Purpura* 7. "Le Fasin", Adanson, Hist. Nat. Sénégal, Coquillages, p. 111, pl. 7, fig. 7; 1942, Fischer-Piette, Jour. de Conchyl., Paris, vol. 85, p. 208, pl. 7, fig. 5 (photo of Adanson's specimen).] Non-binomial.
- 1791 *Buccinum senegalicum* Gmelin, Systema naturae, ed. 13, p. 3477, no. 31 (ad Senegal); refers to Adanson, pl. 7, fig. 7.
- 1791 *Buccinum plicatum* Gmelin, loc. cit., p. 3472, no. 10; refers to Conchyl.-Cab., vol. 2, figs. 379 and 380; Lister, pl. 1002, fig. 67; and others; 1798, Röding, Mus. Boltenianum, pt. 2, p. 29; 1817, Dillwyn, Descript. Cat., London, vol. 2, p. 588. Not Linné, 1758.
- 1792 *Cassidea crumena* Bruguière, Encyclopédie Méthodique, Vers, vol. 1, p. 428, no. 12 (Ascension); refers to Lister, pl. 1002, fig. 67; Conchyl.-Cab., vol. 2, figs. 379 and 380; 1816, Lamarek, loc. cit., pl. 406, Le Liste, p. 3.
- 1835 *Cassis testiculus* Brug., var., Kiener, Coq. Vivantes, Paris, Casque, p. 21, pl. 4, fig. 7.
- 1884 *Cassis testiculus* var. *crumena* Brug., Tausch, Jahrb. Dents. Malak. Ges., vol. 9, pp. 183-184.
- 1935 *Cassis* (*Cypraeacassis*) *crumena* (Bruguière), Bayer, Zoologische Mededeelingen, Leiden, vol. 18, p. 96, 1964, Alvarado, Bol. R. Soc. Español. Hist. Nat. (Biol.), vol. 62, p. 270 (Annobon, Spanish Guinea).
- 1942 *Cassis testiculus* L. var. *senegalica* Gmelin, Fischer-Piette, Jour. de Conchyl., vol. 85, p. 208, pl. 5, fig. 5 (selected type); 1950, Nicklés, Manuels Ouest-Africains, Paris, vol. 2, p. 85, fig. 130.
- 1943 *Cypraeacassis testiculus* form *crumena* Bruguière, Clench and Abbott, Johnsonia, vol. 1, no. 9, p. 3 (in part, due to Cape Verde Ids. record).
- 1948 *Cassis* (*Cypraeacassis*) *senegalica* var. *mamillata* Salmon, Jour. de Conchyl., Paris, vol. 88, p. 159, fig. 1 (Afrique occidentale).

Types—The type locality of *senegalica* is Senegal, West Africa. The type, Adanson's specimen, is in the Museum Nat. Hist. in Paris. The specimen illustrated by Kiener is possibly Bruguière's type of *crumena* and is in the Museum de Genève, Switzerland. Salmon's variety or form, *mamillata* is in the Museum Nat. Hist. Paris.

Records—Senegal (Nicklés, 1950, p. 85, fig. 130). Bissau, Portuguese Guinea (Nobre, 1909, Suppl. 2, p. 27). Santiago, Cape Verde Islands (MCZ). Cabo de San Juan, Spanish Guinea (Carnegie Mus.). Ascension (MCZ). St. Helena (Th. Mortensen, 1930, Zool. Mus. Copenhagen). Sao Thomé Id.; Gaboon and French Congo (Nicklés, 1950, p. 85). Port Gentil and Pointe Noire, Congo (Nicklés, 1952, vol. 92, p. 147). Angola (Nobre, 1909, Suppl. 2, p. 27).

Fossil records—Madeira (Pleistocene?) (Mayer, 1864, in Hartung, Geol. Besch. Madeira u. Porto-Santo, p. 254).



Plate 50. *Cypraeacassis testiculus* subspecies *senegalica* (Gmelin, 1791). [Eastern Atlantic]. Holotype of *Cassis crumena* Bruguière. Mus. Geneva. 93.9 mm. in length. The pinholes are due to a boring sponge growth.

European Tertiary *Cypraecassis*

A number of fossil species occur in the Tertiary of Europe which evidently represent the stock of Recent *Cypraecassis testiculus* (Linné) of West Africa and the Caribbean. A fossil specimen of *Cypraecassis* is in the Paris Museum with a specific name of *conglobata* Brocchi, but that name was used only in connection with a buccinid or nassariid species in 1814 by Brocchi.

Cypraecassis subtesticulus (Orbigny, 1852)

Range—Lower and Middle Miocene of Europe

Synonymy—

- 1817 *Cassis plicata* DeFrance, Dictionnaire Sciences Naturelles, Paris, vol. 7, p. 210 (Plaisantin, Italy). Non Linné, 1758. Types fig'd. in Sacco, 1908, Palaeontologia Universalis, pl. 163a.
- 1829 *Cassis marginatus* de Serres, Geogn. Terr. Tert., p. 119, pl. 2, figs. 13, 14. Non Borson, 1820, which is a *Cymatium*.
- 1840 *Cassis testiculus* Lam., Grateloup, Conchyliologie Fossile des Terrains Tert. bassin l'Adour, vol. 1, pl. 1, fig. 13.
- 1852 *Cassis subtesticulus* Orbigny, Prodrôme Paleont. Strat. Universelles, Paris, vol. 3, p. 90, no. 1669. Refers to Grateloup, pl. 1, fig. 13.
- 1890 *Cassis (Cassidea) marginata* vars. *ornata*, *initialis* and *savonensis* Sacco, I Moll. Terr. Terz. Piemonte, pt. 7, pp. 23-24, pl. 1, figs. 19, 20.
- 1890 *Cassis (Cassidea) protesticulus* Sacco, loc. cit., p. 24, pl. 1, fig. 21 (Piacenziano: Fornaci).
- 1891 *Cassidea crumena* var. *atuberculata* Sacco, I Moll. Terr. Terz. Piemonte, pt. 10, p. 3 (Astiano).
- 1908 *Cypraecassis marginata* de Serres, Sacco, Palaeontologia Universalis, pl. 163a. Sacco's vars. *ornata*, *savonensis* and *initialis* fig'd.
- 1908 *Cassis rusciniensis* Fontannes, Sacco, Palaeontologia Universalis, p. 163a (Rhône, France; Pliocene). I cannot locate Fontannes' original description.
- 1963 *Cypraecassis subtesticulus* Orbigny, Glibert, Institut Royal Sci. Nat. Belgique, mémoires, ser. 2, fasc. 73, p. 112.

Cypraecassis cypraeiformis (Borson, 1820) (Pl. 51)

Range—Middle Miocene of Europe.

Synonymy—

- 1820 *Cassis cypraeiformis* Borson, Memorie della Accademia di Torino, vol. 25, p. 229, pl. 1, fig. 20 (Colli torinesi).
- 1890 *Cassidea cypraeiformis* Borson, Sacco, I Molluschi Terr. Terz. Piemonte, pt. 7, p. 19, pl. 1, fig. 14 (with vars. *crassilabiata*, *tuberculosa* and *reticulosa* all Sacco, 1890).
- 1951 *Cassis cypraeiformis* Bors., Friedberg, Mieczaki Miocenskie Krakeu, pt. Gasteropoda, p. 113 (Korytnica, Poland).
- 1963 *Cypraecassis cypraeiformis* Borson, Glibert, Institut Royal Sci. Nat. Belgique, ser. 2, fasc. 73, p. 112.

Cypraecassis pseudocrumena (Sacco, 1890) (Pl. 52)

Range—Pliocene of Italy and France.

Remarks—This form is so close to the Recent specimens of *testiculus* from West Africa that it probably should be considered a subspecies or synonym. Orbigny's original name *pseudocrumena* was not validated until 1890 by Sacco.

Synonymy—

- 1852 *Cassis pseudocrumena* Orbigny, Prodrôme Paleont. Strat. Universelle, Paris, vol. 3, p. 177, no. 238. *Nomen nudum*.
- 1890 *Cassidea crumena* var. *pseudocrumena* "Orbigny", Sacco, I Moll. Terr. Terz. Piemonte, pt. 7, p. 21, pl. 1, fig. 17 (with subvars. *multinodosa*, *ornata*, *venusta*, *testiculoides*, pl. 1, fig. 18, *raritytuberculata*, *miocenica* all Sacco, 1890).
- 1963 *Cypraecassis pseudocrumena* Orbigny, Glibert, Institut Royal Sci. Nat. Belgique, mémoires, ser. 2, fasc. 73, p. 112.

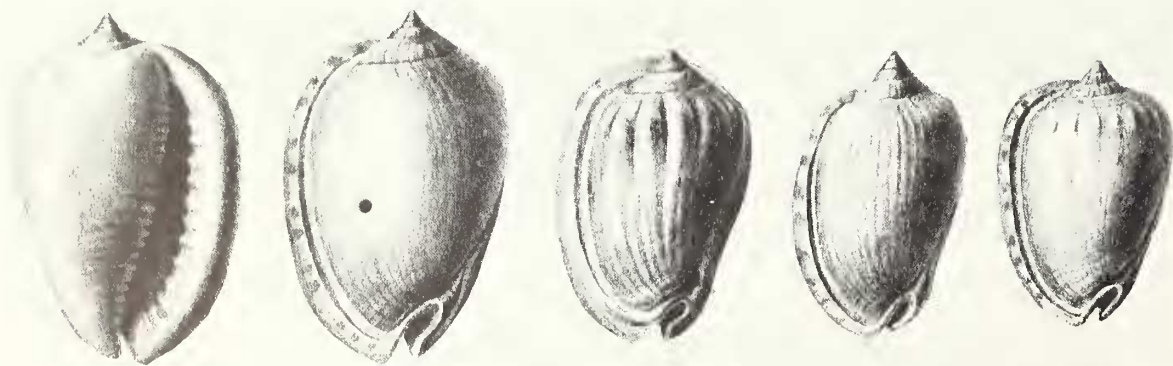


Plate 51. Variation in sculpturing in the European Miocene *Cypraecassis cypraeiformis* (Borson, 1820). 35 to 65 mm. in

length. (all from Hoernes and Auinger, 1884, pl. 17, figs. 7-10).



Plate 52. *Cypraeacassis pseudocrumena* (Orbigny, 1852). Tertiary of Europe. Left fig.: forma *multinodosa* Sacco, 1890. 50 mm. Right fig.: forma *ornata* Sacco, 1890. 52 mm. (both from Sacco, 1904, pl. 20, figs. 3 and 4).

Cypraeacassis subcrumena (Orbigny, 1852)

Range—Lower Miocene of Europe.

Synonymy —

- 1840 *Cassidaria crumena* var. Grateloup, Conchyliologie Fossile des Terrains Tert. bassin l'Adour, vol. 1, pl. 1, figs. 2, 3.
 1852 *Cassis subcrumena* Orbigny, Prodrôme Paléont. Strat. Universelle, Paris, vol. 3, p. 90, no. 1665. Refers to Grateloup, pl. 1, figs. 2, 3.
 1924 *Cypraeacassis subcrumena* d'Orb., Cossmann and Peyrot, Actes Soc. Linn. Bordeaux, vol. 75, p. 87, pl. 12, fig. 4, 5.

Cypraeacassis tenuis (Wood, 1828)

(Pl. 4, fig. 7)

Range—Lower California to Clipperton, the Galapagos Islands, and to Ecuador.

Remarks—This is the largest and least common of the two Eastern Pacific members of this genus. Its 4- to 5-inch shell is characterized by its relatively thin walls, by the well-developed posterior siphonal canal, by its last varix being reflected backward along its entire length, and by the presence of dark-brown stains between the whitish teeth on the lower part of the columella. Its posterior siphonal canal is similar to that of *Cassis tessellata* (Gmelin) from West Africa, but the latter species has strong former varices in the spire, and a white peristome. In some areas, such as La Paz, Mexico, and the Galapagos, shells are cast on the beach after storms. No authentic records exist for the mainland of Ecuador.

Hertlein and Allison (1960, Veliger, vol. 3, p. 14) found dead specimens on the beaches of

Clipperton Island, and surmised that this species was "possibly responsible for predation on the common sea urchin, *Tripneustes gratilla*, many tests of which bear single small perforations on side or upper surface."

Description—Adult shell 68 to 125 mm. (about 2-3/4 to 5 inches) in length, thin-shelled but strong, roundly elongate, with a broad, thin, parietal shield, with spiral rows of small-knobbed cords on the shoulder, and colored tan with light-brown flecks and maculations. Nuclear whorls 4, relatively large, bulimoid, smooth, the first 2 whitish, the last 2 brownish. First 2 post-nuclear whorls smooth, except for numerous, microscopic, spiral threads. Body whorl with 10 to 13 low, flattish, irregularly-sized spiral cords of which the uppermost bears 7 to 9 moderately large, rather evenly-sized, low, rounded knobs. There may be 2 or 3 similar rows of smaller knobs below. In some specimens the very low cords on the base of the shell bear numerous, elongate, raised, whitish, axial bars. Parietal shield well-developed, except on the parietal wall where the spiral rows of brown squares show through the weak, clear glaze. Posterior siphonal canal well-developed and fluted. Spire may have 1 or 2 extremely weak former varices which are more like "resting stages" in the growth of the whorls. Outer lip broad, reflected, glossy, cream with about 6 mauve bands, and with about 20 to 25 white, spiral teeth which may occur in pairs and have dark-brown between the ones at the lower third of the outer lip. Columella dark-brown and with 10 to 14 strong, white, spiral teeth. True and false umbilicus open and deep. Periostracum very thin, light-brown and usually worn away in adults. Operculum very small, oblong-oval, horny, brown and rough.

Measurements (mm.)—

length	width	no. whorls	
125.0	70.0	6+	large; Galapagos
115.0	58.0	9	average; Galapagos
91.2	54.7	7+	holotype of <i>massenae</i> Kiener
68.5	41.0	7+	small; Galapagos

Synonymy —

- 1828 *Cassis tenuis* Wood, Supplement to Index Testac., London, p. 33, pl. 4, fig. 4 (no locality); 1848, Reeve, Conch. Icon., vol. 5, Cassis, pl. 6, fig. 13a-c. (Galapagos; 6 fms., sandy mud).
 1835 *Cassis massenae* Kiener, Coquilles Vivantes, Paris, vol. 8, Cassis, p. 17, no. 9, pl. 8, fig. 14 (les mers d'Amerique).
 1932 *Cassis tenuis* Gray, Pilsbry and Lowe, Proc. Acad. Nat. Sci. Phila., vol. 84, p. 121.
 1935 *Cassis* (*Cypraeacassis*) *tenuis* Gray, Bayer, Zoologische Mededelingen, Leiden, vol. 18, p. 97.

- 1958 *Cassis* (*Cypraecassis*) *tenuis* Wood, Keen, Sea Shells of Tropical West America, Stanford, p. 340, fig. 312.
1961 cf *Cypraecassis tenuis* Woodring and Malavassi, Jour. Paleo., vol. 35, no. 3, p. 494, pl. 69, figs. 1, 2.
1963 *Cypraecassis tenuis* (Wood), Emerson and Old, Amer. Mus. Novitates, no. 2153, p. 12, fig. 10.

Types—Wood's type of *tenuis* has not been located. He gave no locality. We designate La Paz, Mexico, as the restricted type locality. Kienner's type of *massenae* is in the Museum de Genève (1962).

Records—MEXICO: Salinas Bay, Carmen Id.; La Paz (both USNM); Espiritu Santo Id., near La Paz (Pilsbry and Lowe, 1932, p. 121); Cape San Lucas (USNM); Tres Marias Ids. (Emerson and Old, 1963, p. 13). GALAPAGOS: Narborough Id. (R. E. Snodgrass, 1899, ANSP); Gardner Bay, Hood Id.; Conway Bay, Indefatigable Id.; Post Office Bay, Charles Id. (all H. A. Pilsbry, Pinchot Exped., 1929, ANSP); Iguana Cove, Albemarle Id. (ANSP); James Id. (USNM); Banks Id. (Stanford Univ.). CLIPPERTON ID.: (Cal. Acad. Sci.). Ecuador (Keen, 1958).

Fossil records—PLEISTOCENE: 5-10 meters above sea level, James Bay, James (San Salvador) Id. (Hertlein, 1939, vol. 23, p. 370). Woodring and Malavassi's 1961 Miocene record from Costa Rica is based upon a specimen which I would hesitate to place in the family Cassidae.

[These occasional blank areas occur between genera and subgenera to permit the insertion of new material and future sections in their proper systematic sequence.]

Subgenus *Levenia* Gray, 1847

Type: *Cypraeacassis coarctata* (Sowerby, 1825)

There is only one species in this subgenus which differs from *Cypraeacassis* only in having the upper third of the outer lip reflected inwardly. The dentition of the aperture is more like that of the West Indian *C. testiculus* than that of the other Eastern Pacific species, *C. tennis*.

Synonymy—

1847 *Levenia* Gray, Proc. Zool. Soc. London for 1847, p. 137 (type by monotypy: *Cassia coarctata* Sowerby).

Cypraeacassis coarctata (Sowerby, 1825)

(Pl. 4, fig. 8, pl. 53)

Range—Gulf of California to northern Peru.

Remarks—This is a moderately common species with a wide, western American geographical distribution. It differs from the only other Eastern Pacific *Cypraeacassis*, *tennis* (Wood), in having a proportionately much heavier shell, in having both the true and false umbilicus almost sealed, in having brown stains between the teeth, in having the upper third of the outer lip pinched in, and in lacking the posterior siphonal canal. This species is reported by Sowerby (1837, p. 369) to have an operculum. Live specimens have a fairly well-developed periostracum.

This species was reported from the Galapagos Islands on the word of Hugh Cuming, but I have never found another record and question its authenticity.

Habitat—It is not uncommonly found dead on beaches. It has been dredged at depths of 4 to 6 fathoms; and Dr. Blenn R. Bales (*in litt.*, 1938) reports that he collected several live adults at Acapulco clinging to the sides of rocks between tide marks. Reeve (1848, *Cassia*, sp. 14) reported that Hugh Cuming collected it in a similar habitat.

Description—Adult shell 40 to 70 mm. (1-1/2 to 2-3/4 inches) in length, solid, moderately heavy, elongate, with 4 spiral rows of indistinct knobs, with a narrow, posteriorly constricted aperture,

and colored with dark-brown and gray maculations. Nuclear whorls rather large, 3-1/2 to 4, bulimoid, brown to tan, and smooth. Postnuclear whorls 4, with microscopic spiral threads crossed by fine axial growth lines which may form minute beads. Last whorl with 4 spiral rows of 5 or 6 low, indistinct knobs which are less prominent on the lowest cord. True umbilicus usually sealed by a cream and orange extension of the parietal callus. False umbilicus narrow, small, deep, and with whitish orange walls. Outer lip turned inward at the upper third, and flaring outward at the lower third, but not recurved. Inner edge of orange and cream outer lip with 12 to 18 elongate whitish teeth. Parietal wall often glazed thickly with orange-cream. Columella with numerous raised, white spiral teeth. Periostracum moderately thick and brownish, but usually flakes off in dry specimens. Operculum reported to be present.

Measurements (mm.)—

length	width	no. whorls	
74.0	—	5+	large; Cleofas Id., Mexico
71.0	40.0	8	large; Sowerby's holotype
70.0	36.5	8	large; Ecuador
67.0	33.5	7+	large; Acapulco
53.5	28.0	8	average; Ecuador
40.0	21.9	7+	small; Mazatlan

Synonymy—

1825 *Cassia coarctata* Sowerby, Cat. Shells Tankerville, London, p. 70 (nude), appendix, p. xxi, no. 1826 (New Zealand. . .); 1837, Sowerby, Mag. Nat. Hist. (Charlesworth ed.), new series, vol. 1, p. 367, fig. 28 c (operculum).



Plate 53. *Cypraeacassis* (*Levenia*) *coarctata* Sowerby, 1825. [Eastern Pacific]. Holotype. British Museum (Natural History). 71.0 mm. in length.

- 1828 *Buccinum coarctatum* Wood, Supplement to Index Testac., London, p. 33, pl. 4, fig. 5.
- 1832 *Cassis coarctata* Wood, Valenciennes, in Humboldt and Bonpland, Recueil d'Observ. Zool., vol. 2, p. 313 (Acapulco; and Peru).
- 1835 *Cassis coarctatum* Valenciennes, Kiener, Coquilles Vivantes, vol. 8, p. 19, pl. 8, fig. 15 (du Pérou à Acapulco). 1852, C. B. Adams, Ann. Lyceum Nat. Hist., vol. 5, p. 103 [reprint], no. 111 (Panama).
- 1837 *Cypræacassis coarctata* Valenciennes, Stutchbury, Mag. Nat. Hist. (Charlesworth, ed.), new series, vol. 1, p. 216, 471.
- 1848 *Cassis coarctata* Gray, Reeve, Conch. Icon., vol. 5, Cassis, pl. 6, sp. 14; 1924, A. A. Olsson, Nautilus, vol. 37, p. 124; 1932, Pilsbry and Lowe, Proc. Acad. Nat. Sci., 1924, p. 121.
- 1935 *Cassis (Cypræacassis) coarctata* Gray, Bayer, Zoologische Mededeelingen, vol. 18, p. 96.
- 1958 *Cassis (Levenia) coarctata* Sowerby, 1825, Keen, Sea Shells of Tropical West America, Stanford, p. 340, fig. 313; 1963, Emerson and Old, Amer. Mus. Novitates, no. 2153, p. 14, fig. 11.

Types—From the label on Sowerby's holotype in the British Museum, it would appear that his specimen was used also by Wood in 1828

(Index Testac., pl. 4, fig. 5). Sowerby erroneously supposed his specimen might have come from New Zealand. I hereby designate Acapulco, Mexico, as the type locality.

Records—LOWER CALIFORNIA: (west side) Santa Margarita Island (USNM). (Gulf of California): Tiburon Id. (USNM); Santa Rosalia (ANSP; MCZ); San José Id. (USNM); Concepcion Bay; Santa Cruz Id.; Aqua Verde Bay (all USNM); Cape San Lucas (J. Xantus, MCZ; La Paz (Pilsbry and Lowe, 1932, p. 121). GULF OF CALIFORNIA (mainland side): Guaymas, Sonora (ANSP; USNM; MCZ); Mazatlan (ANSP; USNM); 10 meters, sand bottom, Ultima Isla, off Mazatlan (A. R. Cahn, coll'n., ANSP); Acapulco (B. R. Bales, ANSP). Tres Marias (USNM). NICARAGUA: Corinto (Pilsbry and Lowe, 1932, p. 121). COSTA RICA: Bahia de Salinas (USNM). PANAMA: Canal Zone (MCZ); Taboga Id., off Panama (ANSP; MCZ); Pedro Gonzales, Perlas Ids. (MCZ). ECUADOR: Punta Paitilla, Santa Elena Peninsula (T. Dranga, ANSP); Manta (USNM); Salinas (Olsson, 1924, p. 124). PERU: Mancora (Olsson, 1924, p. 124).

Fossil records—PLEISTOCENE: Escondido Bay, Oaxaca, Mexico (Schenck, 1926, p. 76); Punta Pulpito, Mexico (Hertlein, 1957); Coronados Id. (Durham, 1950); Cerralvo Id., Mexico (Emerson, 1960). PLIOCENE: Monserrate Id., Baja Calif (Hanna and Hertlein, 1927).

Genus *Phalium* Link, 1807

The shells in this genus are medium-sized, usually having a length of about 25 to 100 mm. (1 to 4 inches). The spire is acuminate and the last whorl well-rounded. Usually the false umbilicus (or siphonal fasciole umbilicus) and the true umbilicus are open. Many species have 1 to 7 former varices showing in the spire. The parietal shield is moderately developed, especially at the lower left region. The thick outer lip bears one row of denticles which in some species are produced into spines at the lower end. The operculum is chitinous and fan-shaped.

A number of subgenera and allied genera have been variously associated with *Phalium*. A careful study of the many morphological characters leads me to submerge such groups as *Semicassis*, *Xenophalium* and *Echinophoria* to subgeneric levels under the one genus *Phalium*. The presence of sharp spines at the base of the outer lip is peculiar to most species of *Phalium sensu stricto*, but in *Phalium bandatum* of the Indo-Pacific, a valid subspecies limited to the Indian Ocean, *exaratum* (Reeve), lacks these spines. The subgenera that we accept vary in their degree of distinctiveness. Some species bear characters common to several subgenera and therefore have in many cases been placed rather subjectively within certain subgenera. The alternative would be to continue erecting new generic names until most genera would be monotypic, a course which I believe would defeat the purpose of a classificatory system based upon phylogenetic relationships.

Subgenus *Phalium* Link, 1807

Type: *Buccinum glaucum* Linné, 1758

The small, warm-water cassids which have a plicated or granulose columellar shield and a well-toothed outer lip are characterized by mottled tentacles and by a multi-dentate, outer marginal radular tooth. No other distinctive shell character appears to be common to all of the species which are placed here in *Phalium*. The type species, *glaucum* (Linné), has 3 or 4 spines at the base of the outer lip, a feature weakly present in two other species—*fimbria* (Gmelin) and *bandatum* (Perry). However, *P. bandatum* subspecies *exaratum* (Reeve), from the western Indian Ocean, and *P. areola* (Linné) and *strigatum* (Gmelin) do not have these spines. Similarly,

the normal number of apical varices in each species varies from none to five. The position of these former varices may produce a "humped back" appearance in three of these species, namely *glaucum*, *areola* and *strigatum*. I believe these characters are of species significance, but, because they appear from species to species in random combination, cannot be used as generic or subgeneric characters. To use these characters, and others, such as the large parietal shield in *P. fimbria*, on the generic level would result in a host of monotypic genera.

Equal difficulty arises in recognizing other closely related groups of species, and, through the years, various workers have employed such names as *Semicassis* and *Tylocassis* on either a generic or subgeneric level. I hesitantly employ *Semicassis* as a subgenus of *Phalium*. The soft

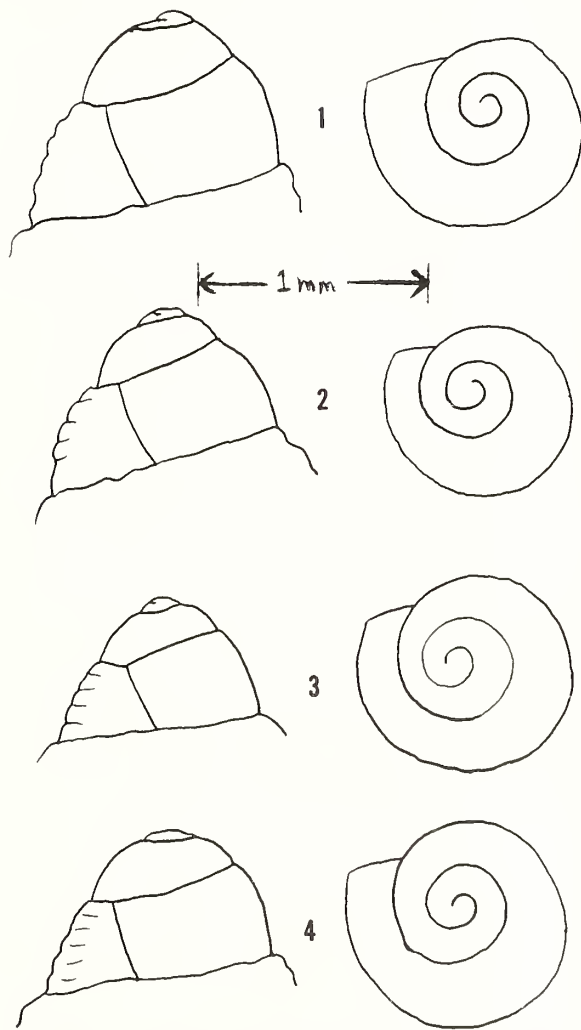


Plate 54. Nuclear whorls of *Phalium* (s.s.). Fig. 1, *glaucum* (Linné). 2, *bandatum bandatum* (Perry). 3, *areola* (Linné). 4, *fimbria* (Gmelin).

Synonymy—

- 1807 *Phalium* Link, Beschreibung der Naturalien-Sammlung, Rostock pt. 3, p. 112 (type by subsequent designation, Dall. 1909, Prof. Paper 59, U.S. Geol. Survey, p. 62: *C. glauca* Linné). Hermannsen's 1852, p. 104, listing is not a type designation.
- 1817 *Bezoardica* Schumacher, Essai nouv. Syst. Vers test., pp. 75 and 248. (type by subsequent designation, Cossmann, 1903, Essais Paléo. Comp., pt. 5, pp. 121, 128: *Buccinum glaucum* Lin.; and by Iredale, 1927, p. 331). Gray, 1847, Proc. Zool. Soc. London, p. 137, invalidly gave two different type designations.
- 1823 *Cassis* Children, Quarterly Jour. Sci., Literature and the Arts, London, vol. 16, p. 129 (type: *Buccinum glaucum* Linn.).
- 1840 *Cassidea* Swainson, Treatise on Malacology, London, pp. 66 and 299. (type by subsequent designation, Hermannsen, 1846, p. 192: *Cassis areola* Linn.). Non *Cassidea* Bruguière, 1789, non *Cassidea* Swainson, 1835, a dubious name. Dall's 1909, p. 61 type claim of *vibex* Linné by Swainson is untrue.
- 1961 *Bezoardicella* Habe, Coloured Illus. Shells of Japan, vol. 2, p. 43, pl. 20. (type hereby designated: *B. decussata* Linné).

parts, radulae and opercula do not appear to differ significantly. Some difficulty exists in separating the shells of *Phalium* (*Phalium*) *bandatum* subspecies *exaratum* (Reeve) and *Phalium* (*Semicassis*) *granulatum* subspecies *undulatum* (Gmelin) of the Mediterranean. The latter differs from the former only in possessing granulations or pimples on the columellar shield (instead of broken, irregular plicae). I consider the *granulatum* complex as a widespread, polytypic species existing in the Mediterranean, the Carib-

bean and the tropical Eastern Pacific, and therefore consider the one character of pimples of weak subgeneric value (*Tylocassis* Woodring, 1928).

Members of *Phalium* feed on echinoderms, live in sand, and build a tower-shaped eggmass made up of small, connected, horny egg capsules.

The group now known as *Phalium* with *glaucum* Linné as type, has been called *Bezoardica*, *Cassidea*, *Casmaria* and *Cassis* by various authors, depending upon which type species has been accepted. The excellent historical details given by Iredale (1927, Record Australian Mus., vol. 15, pp. 325-327) are summarized in our synonymy. However, I differ by considering Swainson's 1835 *Cassidea* as a *nomen dubium*. I do not consider Habe's *Bezoardicella* of sufficient significance to be recognized, even as a subgenus.

True *Phalium* probably had its origin in south Asia during the late Eocene. The Bay of Bengal is now the mid-point in the distribution of four of the species. During the Miocene most species were probably more widely distributed in the Indo-Pacific, with *Phalium areola vavakwana* (Ladd) already as far east as Fiji. Most species appear to be shrinking in range, with some of them leaving semi-isolated "pools", such as *Phalium bandatum exaratum* and the west Indian Ocean populations of *P. areola*.

Key to the Recent Species of *Phalium* (sensu stricto)

- a Shell with axial ribs and a full parietal shield *fimbria*
- a Shell without axial ribs and with a small parietal shield b
- b Base of outer lip with 3 or 4 short spines c
- b Base of outer lip without spines d
- c Body whorl lead gray and malleated or dented *glaucum*
- c Body whorl with weak yellowish bands and squares; smoothish *bandatum*
- d Body whorl strongly, spirally grooved *bandatum exaratum*
- d Body whorl smooth or finely spirally scratched e
- e Last whorl with 5 or 6 rows of squarish, brown patches f
- e Last whorl with narrow, axial, wavy, brown stripes g
- f Posterior (upper) end of outer lip with 2 prickles *decussatum*
- f Posterior (upper) end of outer lip smooth *areola*
- g Posterior (upper) end of outer lip with 2 prickles *decussatum* form *flammeolatum*
- g Posterior (upper) end of outer lip smooth *strigatum*

Phalium glaucum (Linne, 1758)

(Pl. 7, figs. 10-12; pls. 9, 55-57)

Range—East Africa to southern Japan and Melanesia.

Remarks—Adult *Phalium glaucum* are characterized by a rather heavy, rotund, ash-gray shell whose surface may bear weak malleations. The base of the outer lip usually has 3 or 4 strong, pointed spines. Young shells are spirally grooved. This widely distributed species is moderately common, although usually only collected singly or in pairs. It is apt to be confused in the south-west Pacific area with *Phalium bandatum* (Perry), but Perry's species has a higher spire, a more elongate shell and has more pronounced, yellowish banding on the body whorl.

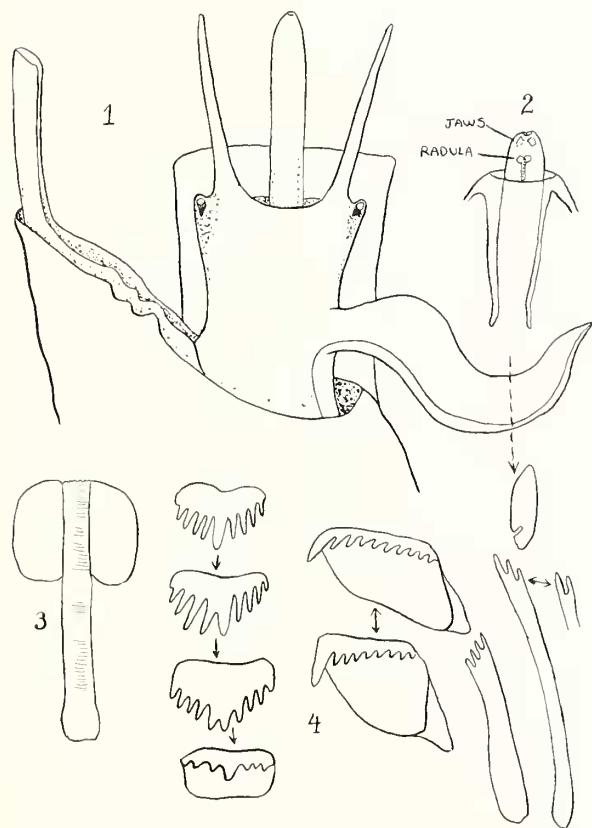


Plate 55. *Phalium glaucum* (Linné). Fig. 1, dorsal view of anterior end showing extended proboscis between the tentacles, and the penis on the right side of the head. Fig. 2, diagram of proboscis partially withdrawn. Fig. 3, radular odontophore. Fig. 4, various views of central, lateral, inner marginal and outer marginal teeth.

The description of the egg-mass given by Rumphius (1705, pp. 83-84) is similar to the egg-mass shown in our plate of *Semicassis*: "another shape of eggs of Gray Caskets [*glaucum*] I found in 1694 in October, being a clump [about the size] of a duck's egg, exteriorly dirty-yellow, rough, composed of many thin layers on top of each other. . . ; in cross-section it was more compact interiorly, of a fleshy red color mixed with spongy white substance, but there were no snails in the interior. A Casket [*glaucum*] was sitting on top and the base was attached to a stone; on the side three or four more snails were sitting" (translation courtesy of Mrs. Tera van der Feen). Rumphius stated that the boiled snail has the smell of leeks or onions. (see plate 9).

Habitat—Occurs in shallow water on sand near dead coral from the intertidal area to 9 fathoms. In Mozambique, it is found at all seasons, although more commonly in March, on exposed sandbanks fronting the open sea (Kurt Grosch, *in litt.*). From Rumphius' remarks (1705, p. 83) it breeds and is more commonly found in September and October in Indonesia. I have collected a number of live specimens on exposed gray sand flats on the west side of Phuket, west Thailand, in late February. They probably feed on the "sand dollars" which are abundant in the same habitat.

Description—Shell 63 to 120 mm. (2-1/2 to 4-3/4 inches) in length, solid, rotund, ash-gray, usually with a malleated surface, with 1 to 3 varices in the spire, and with 3 or 4 strong spines on the base of the outer lip. Nuclear whorls 2-1/2, bulimoid, smooth, translucent dark-tan. A protractively slanting growth line borders it and the spirally beaded post-nuclear whorls. Early post-nuclear whorls rounded and with 7 to 8 spiral grooves and rows of minute beads. The last 2 or 3 whorls become smoothish, except for a prominent row of small, whitish knobs on the upper shoulder and except for weak malleations on the body whorl. Suture finely impressed



Plate 56. Operculum of *Phalium* (*Phalium*) *glaucum* (Linné). Phuket Island, west Thailand. Shell, 69 mm.; operculum, 24 mm.

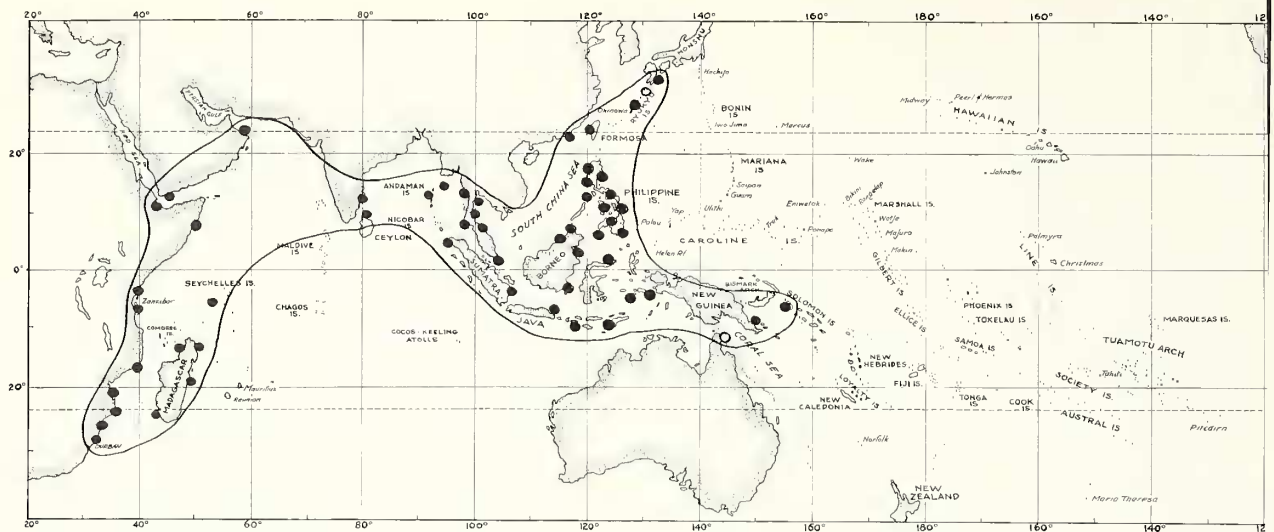


Plate 57. Geographical distribution of *Phalium* (*Phalium*) *glaucum* (Linné).

and bordered below by a weak, whitish gray, spiral swelling. Adults with 0 to 3 former varices showing in the spire. Aperture ovate, dark-brown to tan within. Outer lip strong, recurved, glossy, yellowish to light-orange with irregular banding, and bearing 6 to 20 small denticles on the inner edge. Above, the denticles may be obsolete; below they may extend into the 3 or 4 strong spikes on the base of the outer lip. Columellar shield with a raised left edge, orange-yellow, and with irregular, strong, spiral wrinklins on the columellar side. Umbilicus moderately large and very deep. False umbilicus open, slit-like and deep. Siphonal canal recurved, light-tan with a small purplish brown blotch on the dorsal surface. Operculum corneous, brownish tan, fan-shaped, with a smoothish surface, except for fine concentric growth lines and weak, radial striae and about half the length of the aperture.

Measurements (mm.)—

length	width	no. whorls	
120.0	77.0	7 +	large; Anping, Taiwan Id.
108.5	68.1	9	large; Inhaca Id., Mozambique
102.0	72.0	9	large; Zamboanga, Philippines
90.0	58.2	8 +	average; Okinawa Island
61.7	40.5	6 +	small; Kudat, North Borneo

Synonymy—

- 1758 *Buccinum glaucum* Linné, *Systema naturae*, ed. 10, p. 737 (O. Asiatico); refers to Rumphius, pl. 25, fig. A; Gualtieri, pl. 40, fig. A; 1764, *Mus. Lud. Ulrich*, p. 606, no. 256; 1767, ed. 12, p. 1200, no. 453; 1795, Spalowsky, *Prodrome Syst. Hist. Testac.*, Wien, p. 37, pl. 6, fig. 1; 1956, Dodge, *Bull. Amer. Mus. Nat. Hist.*, vol. 111, p. 188.
- [1786 *Buccinum galea-ferrea* Martyn, *Universal Conch.*, pt. 3, 1786, pl. 91, right figure. Rejected work].

- [1797 *Cassida bezoar* Humphrey, *Museum Calonnianum*, p. 19. New name for *Buccinum glaucum* Linné, 1758. Non-binomial work].
- 1807 *Phalium glaucum* Linné, Link, *Beschr. Natural-Samml.*, Rostok, pt. 2, p. 112; 1869, Frauenfeld, *Verhand. Kaiser-könig. Zool.-Botan. Gesell. Wien*, vol. 19, abh. p. 862 (Nicobar Islands).
- 1817 *Bezoardica vulgaris* Schumacher, *Essai Nouveau Syst. Test.*, p. 248. New name for *Buccinum glaucum* Linné.
- 1822 *Cassis glauca* Linné, Lamarck, *Anim. sans Vert.*, vol. 7, p. 221, no. 6; 1832, Quoy and Gaimard, *Voyage Astrolabe, Zoologie*, vol. 2, pp. 593-596, pl. 43, figs. 9-13.
- 1839 *Cassis bezoar* Gray, *Zoology of Beechey's Voyage*, London, p. 121 (operculum only).
- 1911 *Cassidea strigata* L., Shirley, *Proc. Royal Soc. Queensland*, vol. 23, p. 98 (juvenile). [fide Iredale, 1927, p. 331; wrong reference?].
- 1927 *Phalium* (*Phalium*) *glaucum* (Linné), Iredale, *Records Australian Museum*, vol. 15, p. 331; 1935, Bayer, *Zoologische Mededeelingen*, vol. 18, p. 99.

Types—According to Dodge (1956, p. 188) a specimen conforming to *glaucum* of authors (and also our concept) is in the Linnaean collection in London and may serve as the type. The type locality is "In O. Asiatico", and we further restrict it to Ambon Id., Indonesia.

Records—(see accompanying map)—SOUTH AFRICA: St. Lucia Inlet, Zululand (V. Orr, ANSP). MOZAMBIQUE: Inhaca Id., Delagoa Bay (William Macnae, ANSP); Mozambique City (Kurt Grosch, ANSP); Vilanculos, Bazaruto Bay (J. K. Howard, MCZ); Port Amelia (MCZ). ZANZIBAR: (R. T. Abbott, USNM). KENYA: Lamu Id. (A. Loveridge, MCZ). FRENCH SOMALIA: Dorale, near Djibouti (N. Lavergne, ANSP). SOMALIA: Chisimaio (O. Davis, ANSP). ADEN: Kagimakser (H. Strengers, Rijksmus. Nat. Hist. Leiden). SAUDI ARABIA: Muscat, Gulf of Oman (Don Bosch, ANSP, AMNH). MADAGASCAR: Ankify A. Chavane, ANSP; Ambatoloaka, Nossi-bé (Acad. Exped., 1960, ANSP); Ilanivato, Ile Ste. Marie (R. W. Foster, MCZ). SEYCHELLES: North West Bay, Mahé, (Winckworth, Brit. Mus.). INDIA: Madras

(Brit. Mus.). ANDAMANS: Port Blair (Manchester Mus., Harnett coll'n). CEYLON: Gulf of Manaar (George and Mary Kline, ANSP). BURMA: North Prepara Channel, 52 meters, Anton Brunn Sta. 43, Apr. 1, 1963 (ANSP); Maungmagen, near Tavoy (C. T. Brues, MCZ). THAILAND: (west side) Phuket Id. (Andrew Peters, ANSP); (Gulf of Siam side): Prochuab (G. M. Moore, MCZ); Koh Samet; Koh Chang (both H. M. Smith, USNM). MALAYA: Singapore (S. Archer, ANSP). INDONESIA: Biliton Id., Sumatra; Boesak and Menado, Celebes; Ambon; Timor; Madura, Java; Gulf of Corontalo; Ampunan, Lombok (all Rijksmus. Leiden); Ceram Id. (L. J. Butot, ANSP); Banda Id. (Paleo. Res. Inst. Ithaca); Lho Seumaweh, Atjeh, Sumatra; Sangir; Soengeiliat (all Zool. Mus. Amsterdam). BORNEO: Maruda Bay; Aru, Jesselton (both Mary Saul, ANSP). JAPAN: Tosa (MCZ; ANSP); Miyazaki Pref., Kyushu Id. RYUKYU IDS.: Okinawa (A. R. Cain, coll'n., ANSP); Miyako Id. (Anita Scott, coll'n.). CHINA: Swatow (Moellendorff, Berlin Mus. TAIWAN: Anping (ANSP); Takao; Hoko (Kuroda, 1941, p. 104). PHILIPPINES: Luzon Id., Iba, Zambales (P. de Mesa, ANSP); Cabalao Id., Polillo Ids.; Subic Bay, Zambales (both P. de Mesa, MCZ); Lusong Cove, Bataan (duPont-Academy Exped., 1958, ANSP); Olongapo; Port San Vicente (both USNM). Mindoro Id.: Pinnamalanay (USNM); Paluan Bay (USNM); San Teodoro (MCZ); Naujan (P. de Mesa, MCZ). Cuyo Id.; Jolo Id.; Zamboanga, Mindanao (all ANSP). NEW GUINEA: Fak Fak (Rijksmus. Leiden). Wasior; Merauke (both Zool. Mus. Amsterdam); Oro Bay (ANSP). SOLOMONS: Buin, Bougainville Id., (Fred Parker, ANSP).

Fossil Records—PLIOCENE: Karikal, India (Cossmann, 1903, Jour. de Conchyl., vol. 51, p. 160, pl. 6, fig. 9, as *Semicassis strigata* Gmelin); Poetjangan layers, Rembang, Java (Altena, 1942, p. 93); Billiton, Java (K. Martin, 1881, p. 20).

**Phalium bandatum subspecies
bandatum (Perry, 1811)**

(Pl. 7, figs. 14, 15; pl. 58)

Range—Western Pacific from southern Japan and the Philippines, south through Indonesia to the northern half of Australia.

Remarks—This handsome, moderately common species bears a very close resemblance to *Phalium glaucum* (Linné), but it differs in being proportionately more elongate, in having spiral bands of large, squarish, light yellow-brown blotches on the body whorl and axial flames on the spire, and in usually having more tabulate whorls in its drawn-out spire. *Phalium glaucum* generally has dark, bluish gray covering the weak spiral bands of yellowish, and may have a strongly malleated surface. I can find no significant differences in the varices, dentition on the outer lip, the spines at the base, or the wrinkles on the columellar shield.

The distribution of *bandatm bandatum* is confined to a relatively narrow, north-south area running from central Japan to both sides of Australia. *Phalium glaucum* has a much wider, east-west distribution which extends from East Africa to Melanesia. *P. bandatum* evidently can withstand cooler waters. I can find no significant differences in the Japanese, East Indian and Australian populations.

Habitat—Mrs. Joy Kerslake informs me that in Queensland this species is sometimes captured in deep-water prawn nets in great quantities. Bernice Albert has obtained it alive in 4 feet of water in Okinawa, and the "Albatross" dredged it in fresh condition in 18 fathoms in the Philippines. In Western Australia it has been collected at depths from 14 to 40 fathoms on sand bottom.

Description—Shell 55 to 115 mm. (2¼ to 4½ inches) in length, solid, slightly elongate, cream-white with diffused banding and squarish spotting of yellow-brown, usually with a smooth surface, and with 2 or 3 poorly developed spines at the base of the outer lip. Nuclear whorls 2, glossy, opaque-white. Post-nuclear whorls rounded, slightly shouldered, and with 6 to 8 beaded cords which disappear in the last two whorls. Last two whorls shouldered by a spiral row of small whitish knobs. Whorls bear 1, 2 or no former varices. Color of outer shell white or cream and with 5 spiral, light-yellowish bands on which are darker squares of yellow-brown. Axial flames of brownish are fairly prominent below the suture and may extend on to the body whorl. Exterior of



Plate 58. *Phalium bandatum bandatum* (Perry). Holotype of *Cassis coronulata* Sowerby. British Museum (Natural History). 91.2 mm. in length.

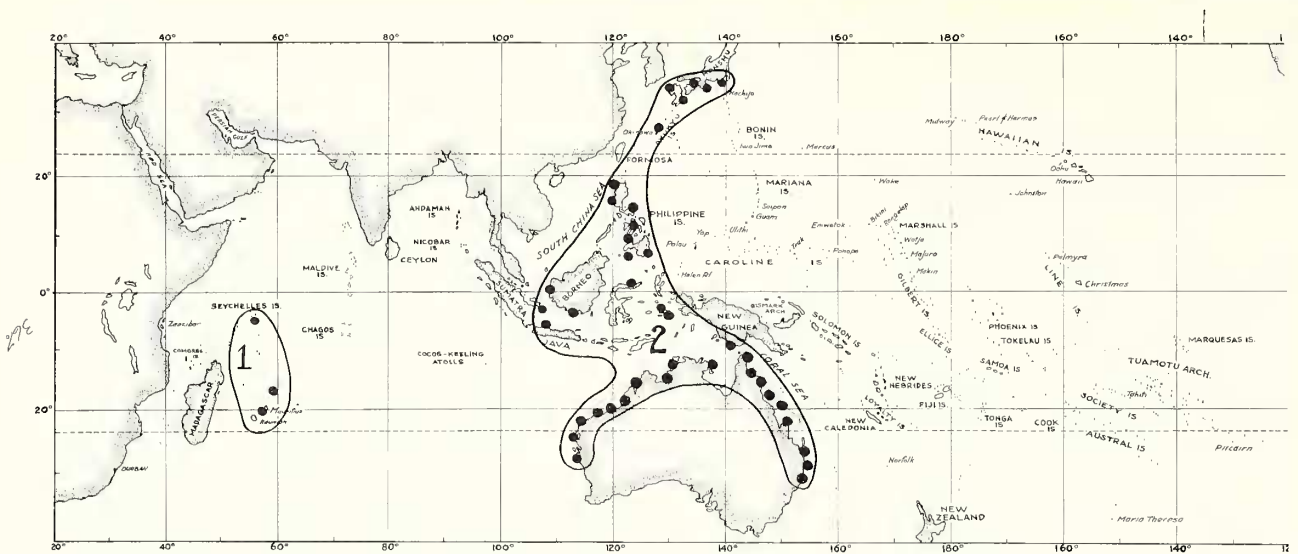


Plate 59. Geographical distribution of *Phalium* (*Phalium*) *bandatum* (Perry). 1, subspecies *exaratum* (Sowerby); 2, typical subspecies *bandatum* (Perry).

siphonal canal and the gutter to its right are usually stained with light purplish brown. Interior of aperture whitish to dark brownish. Columella shield and glossy outer lip whitish, yellowish or brownish orange. Other features, including dentition of the outer lip, similar to those in *Phalium glaucum*.

Measurements (mm.)—

length	width	no. whorls	
124.0	73.0	9	large; Jolo Id., Philippines.
115.0	69.0	7+	large; Cebu City, Philippines
95.0	59.0	6+	average; Cebu City, Philippines
91.2	54.0	7+	Type of <i>coronulata</i> Sby.
85.7	49.0	9	Sagami Bay, Japan
84.5	46.9	9	Queensland, Australia
55.6	35.7	8	small; Queensland, Australia

Synonymy—

- 1811 *Cassidea bandata* Perry, Conchology, London, pl. 34, fig. 2 (East Indies).
 1825 *Cassis coronulata* Sowerby, Catalogue Shells, Earl Tankerville, London, p. 70, no. 1823 and appendix, p. xx, no. 1823 (no locality); 1848, Reeve, Conch. Icon., vol. 5, Cassis, pl. 12, fig. 31 (Philippine Islands).
 ?1828 *Cassis muricata* Menke, Synopsis Methodica Molluscorum, Pymont, p. 36 and 86 (ad Javam); 1830, ed. 2, p. 144 [Young and *nomen oblitum*].
 1835 *Cassis glauca* Brug., var. Kiener, Coquilles Vivantes, Paris, vol. 8, Cassis, p. 27, 29, pl. 1, figs. 1 (living animal in color).
 1873 *Semicassis* (*Phalium*) *coronulata* Sowerby, Brazier, Proc. Zool. Soc. (London) for 1872, p. 838 (New South Wales).
 1910 *Cassidea coronulata* Sowerby, Hedley, Report Australian Assoc. Adv. Science, Brisbane, for 1909, p. 361 (Queensland).

1918 *Phalium coronulatum* Sowerby, Hedley, Jour. and Proc. Royal Soc. New South Wales, (1917), vol. 51, p. 67.

1927 *Phalium bandatum* (Perry), Iredale, Records Australian Museum, Sydney, vol. 15, p. 332; 1935, Ch. Bayer, Zoologische Mededelingen, vol. 18, p. 99.

Nomenclature—Iredale in 1927 associated the name *Cassidea bandata* Perry, 1811, with Sowerby's better-known *Cassis coronulata* Sowerby, 1825, I think on rather slim grounds, for Perry's poor figure and the descriptive words "shell white and gray—mouth a lively brown" fit some specimens of *glaucum* Linné which have bands of color on the parietal wall. In view of Perry's remarks concerning the "red" spots on the outer lip, and because Kuroda, Ch. Bayer and others acceded to this view, I am also employing the name *bandatum*.

Among the early woodcut drawings of this species are those of Seba, 1758, pl. 71, figs. 14 and 15, but I know of no valid names that have been applied to them.

Types—I was unable to find Perry's type of *Cassidea bandata* in any of the major museums in England in 1962. The type locality is "East Indies". I further restrict it to Olango Island, just east of Cebu City, Cebu Island, Philippines. Sowerby's type of *coronulata* from the Tankerville collection is in the type collection of the Mollusca Section of the British Museum (of Natural History) in London (1962). Sowerby gave no locality.

Records—JAPAN: Kagoshima; Nagasaki; Hirado, Hizen; Oshima (all USNM); Kii, Honshu, 10 fms.; Miyazaki Pref., Kyushu Id.; Nagasaki (all MCZ); Tosa; Sagami Bay; Wakayama (all ANSP). RUYKYU ID.: 4 ft., Chinen sand flat, Okinawa Id. (Bernice Albert, ANSP). PHILIPPINES: San Miguel

Id., Albay Prov., Luzon Id. (duPont-Academy Exped., 1958, ANSP); Alabat Id., Luzon Id.; Mariveles, Bataan, Luzon Id. (both Sally Kaicher, coll'n.); Subic Bay and Atimonan, Luzon Id. (both USNM); Olango Id., Cebu Id. (E. Zambo, ANSP); Zamboanga, Mindanao Id. (ANSP); Davao Bay, Mindanao Id.; Jolo Id., Sulu Sea; 18 fms. off Tataan Id., "Albatross" station 5156 (all USNM). INDONESIA: Biliton Id., Sumatra; Amboma; Menado, Celebes Id., (all Rijksmus. Nat. Hist. Leiden); Ceram Id. (L. J. Butot, ANSP). BORNEO: Mampawa (Berlin Mus.). NEW GUINEA: Merauke (south coast) (Zool. Mus. Amsterdam). AUSTRALIA: Western Australia: 40 fms., off Dirk Hartogs Id., Shark Bay; 23 fms., off Delambre Id., Dampier Archip.; 20 fms., off Roebourne; 23 fms., off Legendre Id.; 14 fms., off Sholl Id., (all Weaver and King, 1960, BPBM); La Grange Bay (A. R. Whitworth, ANSP); Mount Yokina (V. Orr, ANSP); Geraldton (West Aust. Mus.); Abrolhos Ids. (A. Kalhins, coll'n.); Northern Territory: Port Samson; off Darwin (both A. R. Cahn coll'n., ANSP); 15 fms., off Cape Ford (Vernon Wells, ANSP); Yirrkala, Arnhem Land; Groote Eylandt, Gulf of Carpentaria (both R. R. Miller, USNM). Queensland: Bedford Beach (Mrs. J. A. Grigg, USNM); Brampton Beach, Bowen (USNM); sand flats, Port Douglas (Tony Marsh, ANSP); Noosa Beach (ANSP); Magnetic Id., near Townsville; Darnley Id., Torres Straits; Bedford Beach, Cooktown; Burleigh Heads (all MCZ); Yeppoon Beach, near Rockhampton (Mrs. A. R. Bowman, ANSP); off Caloundra (Joy Kerslake, ANSP). New South Wales: off Newcastle (T. Hartley, ANSP); Woolgoolga (Joy Kerslake, ANSP); 30 fms., off Evans Head (T. A. Garrard, ANSP).

Fossil records—None reported.

***Phalium bandatum subspecies
exaratum* (Reeve, 1848)**

(Pl. 7, fig. 17; pl. 60)

Range—Central Indian Ocean from the Seychelles to Réunion to the Cargados Islands. (Possibly Mauritius and the Chagos).

Remarks—This curious, somewhat geographically isolated subspecies is evidently the Indian Ocean replacement for *Phalium bandatum bandatum* (Perry) of the Western Pacific. Deshayes (1863, p. 114) was the first to ascribe a definite locality, and subsequent authors have outlined its present known range. *P. exaratum* is distinguished from *bandatum* by the spiral grooves on the body whorl of adults, by the very granular or beaded upper whorls, by the less pronounced shouldering of the whorls, and by the absence or reduction of the three spines at the base of the outer lip. The name *exaratum* is the Latin for plowed up or furrowed, evidently in allusion to the spiral, incised lines on the body whorl. Very young *bandatum* have these spiral cords.

Curiously, the shell is very similar to *undulatum* (Gmelin, 1791) of the Mediterranean, particularly with regard to spiral sculpturing, varical features and coloring. However, *undulatum* has the significant, granular pimples on the columellar shield and a proportionately higher spire. The resemblance in the spiral grooving is evidently superficial.

Habitat—Not known, although presumably on sand bottom in several feet of water.

Description—Shell 75 to 100 mm. (3 to 4 inches) in length, solid, rotund, spirally sculptured, with a coarsely granulated spire and with indistinct, irregular, yellowish brown blotches on the last whorl. Nuclear whorls not observed. Whorls about 7. Early postnuclear whorls coarsely beaded, later whorls with 4 to 6 spiral cords, usually beaded, on the shoulder. Body whorl with about 15 evenly-spaced, spiral incised lines between which are large, almost flat spiral cords. A former varix may be present $\frac{1}{3}$ turn



Plate 60. *Phalium bandatum* subspecies *exaratum* (Reeve). Lectotype. British Museum (Natural History). 82.3 mm. in length.

posterior to the last varix. Aperture elongate; the outer lip with 19 to 23 cream teeth of which the middle 4 or 5 are the largest. Parietal shield well-developed, its left edge smooth and raised. Columellar area with numerous, fine, raised, sometimes interrupted spiral cords. Base of outer lip without prominent projections. Color of shell cream and with 5 spiral rows of irregularly-squarish, indistinct, yellow-brown blotches. Operculum and soft parts unknown.

Measurements (mm.)—

length	width	no. whorls	
109.0	66.1	7 +	large (Amer. Mus. Nat. Hist.)
100.0	64.5	7 +	Seychelles Islands
92.0	52.0	6 +	Mahé Id. (Brit. Mus.)
82.3	47.3	6 +	lectotype (Brit. Mus.)
75.0	49.0	6 +	Cargados Archipelago

Types—The type of *exaratum* is in the British Museum of Natural History, London, where I examined it.

Synonymy—

1848 *Cassis exarata* Reeve, *Conchologica Iconica*, vol. 5, *Cassis*, pl. 12, fig. and sp. 32 (locality unknown); 1863, Deshayes, *Cat. des Moll. l'île de la Réunion*, Paris, in L. Maillard, p. 114, no. 380 (Réunion); 1901, R. Delano, *Cat. Doane Coll. Shells*, Marion Nat. Hist. Soc., Wareham Press, Mass., p. 35 (Réunion).

Records—SEYCHELLES: (ANSP and AMNH); North West Bay, Mahé, (Winckworth, BM). RÉUNION ID.: (Deshayes, 1863, p. 114). MAURITIUS: (Dautzenberg coll'n., Bruxelles). CARGADOS IDS.: Eda Couacaud, 1967, ANSP; (Mauritius Inst.; Liénard, 1877, p. 107). [Castro de Elera's 1896, vol. 3, p. 226, Manila, Philippines, record is probably based upon a young *bandatum*. Salmon's 1948 records are based on young *glaucum* L.]

Fossil records—None reported.

***Phalium areola* (Linne, 1758)**

(Pl. 7, figs. 5-7; pls. 61, 63)

Range—East Africa to Melanesia and Samoa.

Remarks—This well-known and rather widely-distributed species is characterized by the five, spiral rows of large squarish spots of chestnut-brown or yellowish tan on the last whorl. The smooth dorsum is sometimes slightly humped because of an underlying, former varix. Immature specimens have a weak cancellate sculpturing formed by fine axial growth lines and numerous spiral grooves. Adults, including some from northwestern Australia, have a smooth last whorl. Iredale's *agnitum* is an immature form of *areola* (pl. 7, fig. 13). The species appears to be largely limited to large volcanic islands or continental shores. The spotting on the last whorl is variable in color density and in the shape of the spots. I can find no difference between western Indian Ocean and southwest Pacific shells.

I have not seen a sufficient series of *decussatum* (Linné) with good locality data to determine its relationship with *areola*. The former differs in having its shell flattened dorso-ventrally and in having two whitish prongs on the upper end of each varix. To my knowledge, *decussatum* occurs only in Indonesia and Taiwan, although it is likely to be found in the Philippines and perhaps the southeast mainland of China. Provisionally, we are considering the two as separate species.

Habitat—An intertidal, sandy mud-dwelling species, sometimes dredged from depths of two to four fathoms.

Description—Shell 39 to 91 mm. (1-1/2 to 3-3/4 inches) in length (usually 2-1/2 inches), solid, heavy, with 5 rows of large, squarish brownish spots, with 2 to 5 former varices showing in the spire, and with a moderately developed columellar shield. Nuclear whorls 2, bulimoid, smooth, glossy, white or tan. Post-nuclear whorls slightly round, and bearing about 5 to 7 spiral rows of fine beads which disappear in the last whorl. 2 to 5 former varices present in the spire. Last whorl smoothish, but may have weak axial wrinkles on the shoulder and 3 or 4 weak spiral grooves at the base. The dorsum is sometimes humped because of an underlying, former varix. Aperture elongate, tan to dark-brown within. Parietal shield moderately developed, 3 rows of square spots showing on the parietal wall; the left edge of the columellar shield is sharp and is cemented to the lower half of the first former varix. Col-

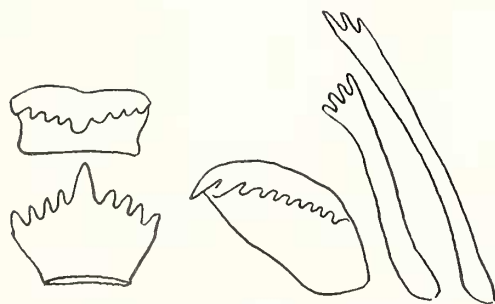


Plate 61. *Phalium areola* (Linné). Radula of female from Phuket, Thailand.

umella with a dozen or so slanting, irregular, raised, whitish plicae and elongate pustules. The upper end of the parietal wall bears 2 to 4 short, oblique plicae. Outer lip thick, whitish, with 5 weak, mauve bars, and with about 15 to 20 small, raised teeth on the inner edge. Siphonal canal short, recurved and stained with mauve-brown on its inner edge. Umbilicus almost sealed by a former varix. False umbilicus sealed or minutely open.

Measurements (mm.)—

length	width	no. whorls	no. varices	
91.0	54.0	8	5	large; locality unknown
83 +	50.0	6 +	6	large; Ryukyu Ids.
69.0	40.7	8	6	Queensland, Australia
63.3	39.0	9	3	average; Luzon, Phil. Ids.
60.0	39.0	8	5	Nossi-bé, Madagascar
57.5	35.0	7	3	holotype of <i>agnitum</i>
39.0	26.1	7 +	4	small; New Britain Id.

Synonymy—

- 1758 *Buccinum areola* Linné, Systema naturae, ed. 10, p. 736, no. 389 (M. Mediterraneo [erroneous]); refers to Buonanni, fig. 154; Rumphius, pl. 25, fig. 1, B. 2; Gualtieri, pl. 39, figs. H, G; and Argenville, pl. 18, fig. 1; 1767, Syst. nat., ed. 12, p. 1199, no. 451; 1956, Dodge, Bull. Amer. Mus. Nat. Hist., vol. 111, art. 3, pp. 183-185.
- 1792 *Cassidea areola* Bruguière, Encyclopédie Méthod., Vers., vol. 1, p. 423, no. 8; 1840, Swainson, Treatise Malacol., London, p. 299.
- 1798 *Cassis alea* Röding, Museum Boltenianum, Hamburg, pt. 2, p. 31; refers to Conchyl.-Cab., vol. 2, figs. 355, 356 and Knorr, pt. 3, pl. 8, fig. 5.
- 1807 *Phalium areola* Link, Beschreibung Naturalien-Samml., Rostok, pt. 2, p. 112, refers to Conchyl.-Cab., vol. 2, fig. 355 (no locality).
- 1807 *Phalium clathratum* Link, loc. cit., p. 113 (no locality).
- 1807 *Phalium extinctum* Link, loc. cit., p. 112 (no locality).
- 1807 *Phalium sulcatum* Link, loc. cit., p. 113 (no locality).
- ? 1808 *Phalium alea* Link, loc. cit., pt. 6, p. 33 (no locality). [*alea* in Sherborn, 1932, p. 820].
- 1816 *Cassis areola* Lamarck, Le Liste, Encyclop. Méth., Vers., pl. 407, p. 3; 1822, Anim. sans Vert., vol. 7, p. 222, no. 9.
- 1817 *Bezoardica areolata* Schumacher, Essai Nouveau System. Test., p. 248 (new name for *areola* Linné, 1758). (no locality).
- 1873 *Semicassis (Phalium) areola* L., Brazier, Proc. Zool. Soc. London, 1872, p. 837 (New South Wales).
- 1877 *Cassis aureola* Brug., Liénard, Cat. Faune Malacologique Maurice, Paris, p. 75 (Seychelles). Error for *aerola* Linné, 1758.
- 1885 *Cassis (Bezoardica) areola* Linn., Tryon, Manual of Conchology, vol. 7, p. 276, pl. 6, fig. 84.
- 1925 *Cassis (Phalium) areola* (Linné), Oostingh, Mededeel. Landbouwh. Wageningen Nederl., vol. 29, pt. 1, p. 116.
- 1927 *Phalium agnitum* Iredale, Records Australian Mus., Sydney, vol. 15, p. 332, pl. 32, fig. 10 (Western Australia).
- 1935 *Phalium (Phalium) areola* (Linné), and form *kusteri* Bayer, Zoologische Mededeelingen, Leiden, vol. 18, p. 98.

1936 *Phalium exaratum* Reeve, subspecies *agnitum* (Iredale), Bayer, Zoologische Mededeel., Leiden, vol. 18, p. 99.

1961 *Bezoardicella areola* Linné, Habe, Coloured Illust. Shells of Japan, pt. 2, p. 43, pl. 20, fig. 8.

Types—According to Dodge (1956, p. 184) “a specimen of the *areola* of authors is present in the Linnaean collection in London”. The original type locality was “In M. Mediterraneo”, but this is evidently erroneous. In 1767, Linné added “Java” to the locality records. Dodge has a lengthy discussion about the early identity of this species. He was unaware of the five later synonyms which we listed above. Iredale’s holotype of *agnitum* from “Western Australia” is in the Australian Museum in Sydney, no. C. 53269.



Plate 62. *Phalium areola* (Linné). Holotype of *Phalium agnitum* Iredale, 1927. Western Australia. Australian Museum no. C 53269.

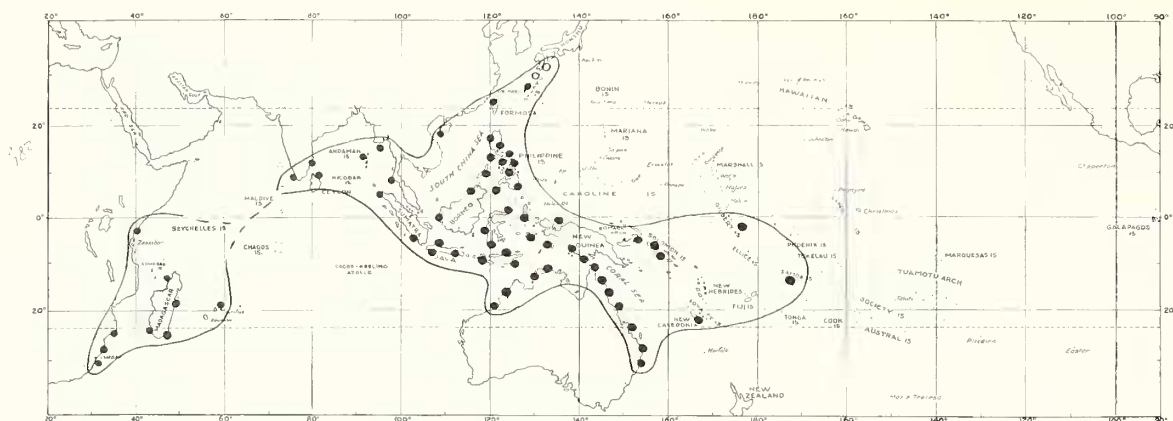


Plate 63. Geographical distribution of *Phalium* (*Phalium*) *areola* (Linné). The species is absent or very rare in the central islands of the Indian Ocean.

Records (see accompanying map)—SOUTH AFRICA: St. Lucia Inlet, Zululand; Umhlali, 30 mi. north of Durban (both V. Orr, ANSP); Isazela, Natal (H. C. Burnup, USNM); Durban (Brit. Mus.). MOZAMBIQUE: Inhaca; Bazaruto Bay (both J. K. Howard, MCZ). KENYA: Lamu Id. (MCZ). MADAGASCAR: Fort Dauphin; Androka, near Tuléar; Tamatave (all C. Petit, Mus. Roy. Hist. Nat. Belgique); Andilana, Nossi-bé (A. Chavane, ANSP). MAURITIUS: (Mauritius Inst.). INDIA: Cochin (Certrude Irvine, ANSP); Madras (Nat. Mus. Wales; BM). CEYLON: Mullaitivu (Jonklaas, ANSP); Trincomalie (MCZ). ANDAMANS: Port Blair (H. M. Parish, BM). BURMA: 53 meters, Prepara North Channel, *Anton Bruun* Sta. 43, Apr. I, 1963 (ANSP). THAILAND: Phuket Id., Bay of Bengal (Andrew Peters, ANSP). CHINA: Sang-ja, Hainan Id. (A. D. Scarlato, Zool. Inst. Leningrad). JAPAN: Miyazaki Pref., Kyushu Id. (Kuroda, 1934, p. 50). RYUKYUS: Miyako Id. (Anita Scott, coll'n.). TAIWAN: Karenko (Kuroda, 1941, p. 104). PHILIPPINES: uncommon throughout Luzon, Mindoro, Palawan, Panay, Samar, Marinduque, and Mindanao Ids. (USNM, ANSP and MCZ). INDONESIA: Wijnkoopsbaai, Java; Banda Id. (both Natuurhist. Mus. Enschede); Menado, Celebes Id. (A. Pasuhuk, ANSP); Bantam, Java (USNM); Benkoelen, Sumatra Id. (USNM); Obi Major, Moluccas; Boelien Weda Bay, Halmahera Id.; Ceram Id.; Ternate Id.; Timor Id.; Misool Id. (all Rijksmus. Nat. Hist. Leiden); Tjilang, Atjeh, Sumatra Id.; Makassar, Celebes Id.; Ende, Flores Id. (all Zool. Mus. Amsterdam); Tjilaoet Eureum, Java Id. (Mus. Roy. Hist. Nat. Belg.). NEW GUINEA: Soembawa; Kaimana (both Mus. Roy. Hist. Nat. Belg.); Djanna Ids. (MCZ); Passang Kajoe, west Celebes Id. (Paleo. Res. Inst. Ithaca); Merauke (USNM); 4 fms., Koer-oedoir Id., Ceelvinck Bay (A. J. Ostheimer, 3rd, ANSP). BISMARCKS: Rabaul, New Britain Id. (E. H. Schlosser, ANSP). AUSTRALIA: Western Australia: Sam's Creek, Port Samson (B. R. Wilson, West. Aust. Mus.); Augustus Id. (MCZ); Northern Territory: Darwin (MCZ). Queensland: Darnley Id., Torres Straits; Flattery Bay, Cooktown; Caloundra; Moreton Bay (all MCZ); Cladstone; Bowen (both USNM); Yeppoon; Tin Can Bay (Joy Kerslake, ANSP); Green Island, near Mackay (T. A. Carward, ANSP); Brompton Beach (T. Hartley, ANSP); Port Douglas (MCZ and Tony Marsh, ANSP). New South Wales: off Trial Bay (Joy Kerslake coll'n); Broken Bay, near Sydney (Aust. Mus.); Newcastle (USNM). SOLOMONS: Guadalcanal Id. (ANSP); Kunua, Bougainville (Fred Parker, 1963, ANSP); Buin, Bougainville (Mus. Roy. Hist. Nat. Belg.). NEW CALEDONIA: Poindimié (Joy Kerslake, coll'n.). CILBERT IDS.: Butaritan (J. S. Edmondson, BPBM). SAMOA: Samatau, Upolu Id. (A. J. Ostheimer, rd., 1955, ANSP).

Fossil records—PLIOCENE: Byoritu Beds of Wangwa, Taiwan (Nomura, 1935, p. 168, pl. 8, fig. 24 (not 38)). Other literature records, unaccompanied by illustrations, may be misidentifications.

Phalium areola
subspecies vavakuana (Ladd, 1934)

Range—Miocene of Fiji.

Remarks—This subspecies is almost indistinguishable from young specimens of *Phalium areola areola* which also have only 2 or 3 varices in the spire and have a cancellate sculpturing on the upper portions of the whorl and spiral bands on the lower portion.

Description—(from Ladd). Shell medium-sized, moderately inflated, spire low, shoulder strong; aperture elongate, narrowed posteriorly, wide anteriorly and reflected as a short, deep canal; siphonal fasciole much inflated. Inner lip thick and heavily callused, its margin detached from the body whorl below; inner margin of inner lip bearing a series of ridges which are long and irregular near the base, inconspicuous immediately above the base, and again prominent posteriorly. Outer lip greatly thickened, reflected, marked by long lirae within. Sculpture of body whorl below shoulder consisting of uniformly narrow, flattened, spiral bands crossed by a few fine axial striae; shoulder nodose or bordered by an elevated rim; above the shoulder on the body whorl the spiral bands are irregularly spaced and are beaded by axial striae; spire cancellated; suture carinated; 2 or 3 smooth, rounded varices present. The holotype retains some of its original color, the body whorl being brown, the lips yellowish.

Holotype (B.P. Bishop Mus., Geol. no. 1206): length 35.0 mm., diameter 22.9 mm. A paratype (B.P. Bishop Mus., Geol. no. 1207) is incomplete but compares favorably in size with the holotype.

Type locality—Station 59, right bank of Wailoa River about 1 mi. west of Nasongo; elevation 995 feet; Viti Levu, Fiji; Suva formation; Miocene.

Synonymy—

1934 *Semicassis* (*Semicassis*) *vavakuana* Ladd, Bull. 119, B.P. Bishop Museum, p. 222, pl. 39, fig. 12.

Records—Known only from the type locality.

Phalium areola

subspecies glaucoides (K. Martin, 1879)

Range—Upper Miocene of Java.

Remarks—I have examined the holotype of *glaucoides* which is 25.3 mm. in length, and found it difficult to separate from Recent specimens of inch-long *Phalium areola*. K. Martin's original figure 8 does not show the axially pinched riblets on the shoulder. He likened his *glaucoides* to the Recent *glancum* (Linné), but the latter rarely, if ever, has a former varix in the spire, lacks the axial beaded riblets on the shoulder and has more widely-spaced, spiral, incised striae on the lower half of the body whorl. The Miocene *glaucoides* appears to differ from the Recent *areola* in having a lower spire and in having stronger beading on the axial riblets on the shoulders.

Synonymy—

1879 *Cassis glaucoides* K. Martin, Die Tertiärschichten auf Java, Leiden, p. 45, pl. 8, fig. 8 (Tji Kantang and Tji Latoron, Java; Upper Miocene). Type in the Rijksmus. Geol. Mineralog. Leiden.

Phalium menkrawitense Beets, 1941

(Pl. 64)

Range—Upper Miocene of east Borneo.

Remarks—This species appears to be related to the Recent *areola* Linné. Although the body whorl is smooth, there appear to be numerous axial wrinkles just below the suture. The holotype is probably an immature specimen. The paratype, although broken, shows a broad parietal shield.

Synonymy—

1941 *Phalium* (*Phalium*) *menkrawitense* Beets, Verhandelungen Geologisch Mijnbouw Genoots, Nederland en Kolon, Geol. Series, vol. 13, p. 85, pl. 4, figs. 180-186 (Upper Miocene; Mangkal, east Borneo).

Phalium strigatum (Gmelin, 1791)

(Pl. 7, figs. 3, 4; pl. 65)

Range—Eastern China, Taiwan and Honshu Island, Japan.

Remarks—This is the only cool water member of the subgenus *Phalium*. It ranges from Hong Kong northward into the Yellow Sea, skirting the west coast of Taiwan, and extending to both sides of northern Honshu Island, Japan. Literature records of its occurrence in Indonesia and the Philippines are undoubtedly erroneous. It has not been authentically reported from the Ryukyus or Bonin Islands nor farther south than Hainan Island on the south China coast.

The shell is very similar in shape and structure to the tropical *Phalium areola* (Linné), and may well be the northern replacement for *areola*. *P. strigatum* differs only in having 12 to 22 narrow, wavy, axial, yellow-brown stripes extending across the body whorl (instead of square spots), and in having slightly stronger wrinklings and spiral plicae on the columella. Many specimens of *strigatum*, especially immature and dwarf, have pronounced spiral grooves on the last whorl, particularly at the base of the shell. Dwarfs occur in 30 fathom depths in the area of Hong Kong. In Japan, it has been dredged from 1 to 50 fathoms. Dr. Odon Debeaux (1863, Jour. de Conchyl., vol. 11, p. 251) gives the phoenetec equivalent for the Chinese name used in Cheefoo for this shell: An-tse-bo-lo-la.

Description—Shell 42 to 110 mm. (about 1-3/4 to 4-1/2 inches) in length, solid, rotund, usually smooth but sometimes spirally grooved, with 3 to 8 (usually 5) varices, colored whitish with 12 to 22 narrow, wavy, axial, yellow-brown stripes on the body whorl, and with strong, spiral wrinklings on the columella. The lowest plica on the columella, well within the aperture, is usually the largest and quite strong. Base of shell usually with a few spiral grooves. In other features, in-



Plate 64. *Phalium menkrawitense* Beets, 1941. Miocene of Mangkal, eastern Borneo, Indonesia. Holotype. 33.2 mm. in length.



Plate 65. *Phalium strigatum* (Gmelin): Holotype of *Cassiss zebra* Lamarck. Mus. Geneva. 86.1 mm. in length.

cluding the operculum, very similar to those in *Phalium areola* (Linné). In fresh specimens the varix and left side of the columellar shield has golden yellow blotches.

Measurements (mm.)—

		no.	no.	
length	width	whorls	varices	
110.0	70.0	8+	8	large; Wakayama, Japan
91.5	55.5	9	7	average; Chiba, Japan
86.1	54.1	8	5	Lamarck's type of <i>zebra</i>
60.0	38.5	8	3	small; Kaneda, Tokyo, Japan
42.0	26.2	8	4	dwarf; Hong Kong

Synonymy—

- 1791 *Buccinum rugosum* Gmelin, *Systema naturae*, ed. 13, pt. 6, p. 3476, no. 27 (locality unknown); refers to Lister, pl. 1014, fig. 78. Non Linné, 1771.
 1791 *Buccinum strigatum* Gmelin, loc. cit., p. 3477, no. 179 ("in Oceano indico"); refers to Conchyl.-Cab., vol. 10, figs. 1457-1458; vol. 2, fig. 356; Favanne, pl. 24, fig. d.
 1798 *Cassiss rugosa* Röding (in part), *Museum Boltenianum*, Hamburg, pt. 2, p. 31, no. 378 in referring to Lister, pl. 1014, fig. 78 (no locality).
 1798 *Cassiss flammifera* Röding, loc. cit., p. 31; refers to Conchyl.-Cab., vol. 10, figs. 1457-1458.

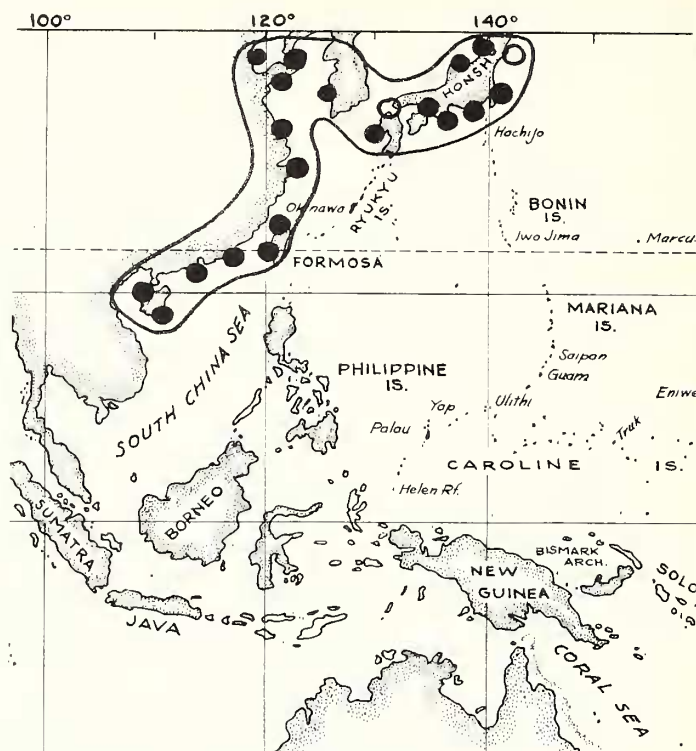


Plate 66. Geographical distribution of *Phalium* (*Phalium*) *strigatum* (Gmelin).

- 1807 *Phalium flammeolum* Link, *Beschreibung der Naturalien; Samml.*, Rostok, pt. 2, p. 112 (no locality); refers to Conchyl.-Cab., vol. 2, figs 367, 368 and vol. 10, figs. 1457, 1458 (in part).
 1811 *Cassiss variegata* Perry, *Conchology*, London, pl. 33, no. 3 (Eastern Seas).
 1822 *Cassiss zebra* Lamarck, *Anim. sans Vert.*, vol. 7, p. 223, no. 10; refers to Lister, pl. 1014, fig. 78; Conchyl.-Cab., vol. 2, fig. 356a; vol. 10, figs. 1457, 1458 and others (*l'Océan indien et des Moluques*); 1826, Crouch, *Illus. Introd. Lamarck's Conch.*, London, p. 35, pl. 18, fig. 7; 1844, Deshayes, loc. cit., ed. 2, vol. 10, p. 28.
 1844 *Cassiss undata* "Martini" Deshayes, *Anim. sans Vert.*, ed. 2, vol. 10, p. 28 in footnote; 1848, Reeve, *Conch. Icon.*, vol. 5, pl. 10, fig. 26.
 1935 *Phalium areola* var. *küsteri* Bayer, *Zoologische Mededeelingen*, Leiden, vol. 18, p. 99; refers to Küster, var. A, in Martini and Chemnitz, *Syst. Conchyl.-Cab.*, ser. 2, vol. 3, pt. 1 b, *Cassiss*, p. 34 which, in turn, refers to Argenville, pl. 15, fig. D.
 1935 *Phalium strigatum* (Gmelin), Bayer, *Zool. Mededeel.*, Leiden, vol. 18, p. 100.

Types—Gmelin probably did not have a specimen. His species was founded on Lister, pl. 1014, fig. 78. We designate Nagasaki, Japan, as the type locality. Lamarck's type of *Cassiss zebra* is in the Lamarck collection in the Geneva Museum of Natural History. His type locality of "*l'Océan indien et des Moluques*" is erroneous. Perry's type of *Cassiss variegata* is probably lost and now unlabelled in some private collection.

Records—CHINA: Pei-tai-ho, North Chihli (ANSP, Zool. Mus. Copenhagen; USNM); Chin-wang-tao, North Chihli (USNM); Tsingtao, Shantung Prov. (MCZ); Cheefoo, Shantung Prov. (Tomlin coll'n., Nat. Mus. Wales); Chusan Id., Chekiang Prov. (Zool. Mus. Berlin); Amoy, Fukien Prov. (T. -C. Yen, 1933, p. 63); 30 fms., Hong Kong (A. J. Staple, ANSP); Sang-ja and Sin-Tsung, Hainan Id. (A. O. Scarlato, Zool. Inst. Leningrad). TAIWAN: Botan-wan, Takao; Hoko (Kuroda, 1941, p. 104); Tainan (ANSP). KOREA: Techun (J. S. Yoo, 1959, p. 29). JAPAN: Honshu Id.: Oga Peninsula, Akita-ken (K. Hatai, ANSP); Onahama Bay, Fukushima Pref. (Nomura and Kakuta, 1933, Saito Ho-On Kai Mus., special report no. 3, p. 15); Kaneda, Tokyo Bay (C. H. Ames, ANSP); Sagami Bay (C. H. Ames, ANSP); Shimoda Bay (I. Sakai, 1935, Biol. Report of Shimoda Marine Biol. Sta., Tokyo, p. 52); Awaji Id. (MCZ); Yokohama Bay (USNM); Enoshima (ANSP); Kamakura; Wakayama; Chiba (all A. R. Calm coll'n., ANSP); Mikawa (north coast), 20 fms. (W. E. Old, Jr., ANSP). KYUSHU ID.: Nagasaki (USNM); Fukuoka Pref. (Takahashi and Okamoto, 1948, Fukuoka Molluscan Club, Cat. Moll. Shells, p. 14, no. 215).

Fossil records—PLIOCENE: Simaziri Beds of Gabusoga, Okinawa Id., a fragment only (Nomura and Zimbo, 1936, Tohoku Imp. Univ. Sci. Reports, series 2, Geology, vol. 18, pt. 3, p. 258).

Phalium decussatum (Linne, 1758)

(Pl. 7, figs. 8, 9; pl. 67)

Range—Southeast Asia and Indonesia.

Remarks—This uncommon species is very close to *areola* Linné, but is probably a distinct species. It is flattened dorso-ventrally, has a cancellate sculpturing in the adult stage and has two small, white prongs on the upper shoulder of each varix. There are usually 6 to 7 varices in the spire of *decussatum* and usually 3 to 4 (rarely 6) in the spire of *areola* and *strigatum* (Gmelin, 1791). To date, *decussatum* has not been recorded from the Philippines.

That two color forms existed in this species was recognized by early workers, including

Linnaeus himself. In 1773, Martini illustrated the two forms, one with *areola*-like spots, the other with *strigatum*-like longitudinal stripes. The former is Linnaeus' type *decussatum*, the latter being the color form *flammeolum* Röding, 1798. Link's 1807 *Phalium flammeolum* is a mixture of Gmelin's *strigatum* and Röding's color form of *decussatum* (Linné). I dismissed the possibility that *flammeolum* might be a form of *Phalium strigatum* (Gmelin, 1791) because of several differing features in sculpture and shape, and because *strigatum* does not occur in the East Indies. The forma *flammeolum* is rare and seldom seen with locality data in collections.

Description—Shell 52 to 70 mm. (2 to 2-3/4 inches) in length, similar to *Phalium areola*, but flattened dorso-ventrally, with a cancellate sculpture on the adult body whorl, and with two, whitish, small prongs on the shoulder of each of the 6 or 7 varices. Two color forms exist, the *typical* forma has 5 or 6 spiral rows of relatively small, square chestnut-brown spots, and a whitish varix with 5 or 6 brown bars. The forma *flammeolum* has 12 to 14 slightly wavy, crowded, axial brown to yellow-brown stripes running the length of the last whorl, and the varix is stained a solid, deep, chestnut- or red-brown. Operculum and soft parts unknown.

Measurements (mm.)—

length	width	no.		
		whorls	varices	
70.5	46.0	7 +	6	typical color; Taiwan
67.6	45.6	7 +	7	<i>flammeolum</i> ; Taiwan
65.3	44.0	7 +	7	<i>flammeolum</i> ; no data
65.0	43.5	7 +	7	<i>flammeolum</i> ; no data
52.2	30.5	7 +	6	typical color; Moluccas

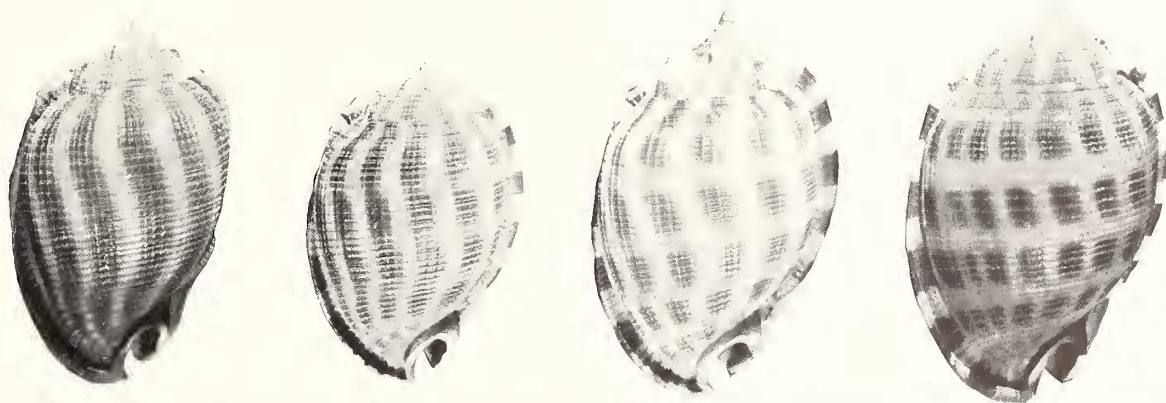


Plate 67. *Phalium (Phalium) decussatum* (Linné, 1758). A series of adults from off Anping, Taiwan, showing variation in size and color patterns from the forma *flammeolum* Röding,

1798, on the far left, and the typical, spotted form in the far right figure. All natural size.

Synonymy—

- 1758 *Buccinum decussatum* Linné, *Systema naturae*, ed. 10, p. 736, no. 388 (no locality); refers to Bonanni, vol. 3, pl. 157 and Gualtieri, pl. 40, fig. B; 1767, loc. cit., p. 1119, no. 450 (in O. Africano); 1823, Mawe, *Limn. Syst. Conch.*, London, pl. 24, fig. 1; 1956, Dodge, *Bull. Amer. Mus. Nat. Hist.*, vol. 111, p. 181.
- 1792 *Cassidea decussata* Linné, Bruguière, *Encyclop. Méthod.*, Vers, vol. 1, pt. 2, p. 425.
- 1798 *Cassis cancellata* Röding, *Museum Boltinianum*, Hamburg, pt. 2, p. 31; refers to Knorr, pt. 2, pl. 10, fig. 3, 4. Non Röding, *ibid.*, p. 30.
- 1798 *Cassis flammeolum* Röding, *Museum Boltinianum*, Hamburg, pt. 2, p. 31, no. 376; refers to *Conchyl.-Cab.*, vol. 2, figs. 367, 368.
- 1807 *Phalium decussatum* "Gmelin", Link, *Beschr. Natur.-Samml.*, Rostok, pt. 2, p. 112 (refers to Martini, *Conchyl.-Cab.*, vol. 2, figs. 360, 361).
- 1822 *Cassis decussata* Linné, Lamarck, *Anim. sans Vert.*, vol. 7, p. 223, no. 11; 1848, Reeve, *Conch. Icon.*, vol. 5, *Cassis*, pl. 2, sp. and figs. 4a, b, c. d. Not Locard, 1886.
- 1961 *Bezoardicella decussata* Linné, Habe, *Coloured Illust. Shells Japan*, pt. 2, p. 43, pl. 20, fig. 7.

Types—There is a specimen of the typical, spotted *decussatum* of authors in the Linnaean collection, according to Dodge (1956, p. 183). It is not known if this is the type. The shell far-



Plate 68. Geographical distribution of *Phalium* (*Phalium*) *decussatum* (Linné).

thest to the right in Gualtieri's pl. 40, fig. B. to which Linné referred is an excellent illustration and should serve as the "type figure" in the event Linné's type specimen is not identified. There was no original type locality, and we now designate the locality of both color forms to Tjilatjap, Java Id., Indonesia.

Records—CHINA: Sang-ja and Yen-dzou, Hainan Id. (A. O. Scarlato, *Zool. Inst. Leningrad*, typical forms). TAIWAN: off Tainan (ANSP); Taihoku-syu; Takao (Kuroda, 1941, p. 104). INDONESIA: Pantai Tjermid, Sumatra Id.; Seongeiliat, Banka Id.; Wijnkoobuati, south Java Id. (all *Zool. Mus. Amsterdam*, all typical form). Surabaya and Tjilatjap, Java (both forms); Timor Id.; Tandjoeng Priok, Java Id. (all *Rijkmus. Nat. Hist. Leiden*). Madura, Java (*Mus. Zool. Bogoriense*). Muntok, Banka Id. (*Berlin Mus.*). BORNEO: (west) Mampawa; Pululo, Bintang Id., Sarawak (both *Berlin Mus.*); Sarikei, Sarawak (Franz Steiner, Dec. 1967).

Fossil records—Semi-fossil (Pleistocene?) from Surabaya, Java Id., Indonesia (*Rijks. Mus. Leiden*). PLIOCENE: Byoritu Beds of Wangwa, Taiwan (Nomura, 1935, p. 169, pl. 8, fig. 38 (not 24)).

Phalium cancellianum Nomura, 1935

(Pl. 69)

Range—Pliocene of Taiwan.

Remarks—Nomura recorded three species of Pliocene *Phalium* from the Byoritu Beds at Wangwa, Taiwan, namely *P. areola* (Linné), *P. decussatum* (Linné) and this new species. It is possible that *cancellianum* is the young of *decussatum*, but because of its very prominent cancellate sculpturing, I am accepting it as a good species.

Description—Shell 30.4 mm. in length, oblong-oval, with a single varix on each mature whorl; test thick and solid; spire short, conical, apex acute. Whorls 8, granular, cancellate, apical 3

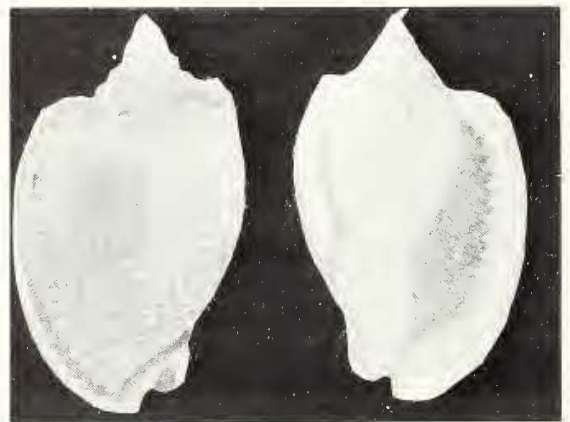


Plate 69. *Phalium cancellianum* Nomura, 1935. Pliocene of Taiwan. Holotype. 31 mm. in length.

- ?1807 *Cassidea tuberculata* G. Fischer, Muséum Demidoff, Moscow, vol. 3, p. 185, no. 23 (locality unknown).
 1822 *Cassis plicaria* Lamarck, Anim. sans Vert., Paris, vol. 7, p. 222, no. 8 (no locality); refers to Seba, pl. 53, figs. 1 and 2; Knorr, pt. 3, pl. 28, fig. 1; Favanne, pl. 25, fig. D4; Conchyl.-Cab., vol. 10, figs. 1459, 1460; 1835, Kiener, Coquilles Vivantes, Paris, vol. 8, Cassis, p. 14, pl. 6, fig. 11.
 1840 *Cassidea plicaria*, Swainson, Treatise on Malacology, London, 1840, p. 299; refers to Conchyl.-Cab., vol. 10, figs. 1459, 1460.
 1844 *Cassis plicata* Linné, Deshayes, Anim. sans Vert., Paris, ed. 2, vol. 10, p. 25, footnote; 1848, Reeve, Conch. Icon., vol. 5, pl. 10, fig. and sp. 27 (Moluccas); 1885, Tryon, Manual of Conchology, Philadelphia, vol. 7, p. 277, pl. 7, fig. 86.
 1935 *Phalium plicatum* (Linné), Bayer, Zoologische Mededeel., Leiden, vol. 18, p. 100.

Nomenclature—Linnaeus' *Buccinum plicatum* was an enigma to the early workers, including Martini (1773), Schröter (1783), Chemnitz (1788), Bruguière (1792) and Dillwyn (1817). Hanley (1855, p. 241) and Dodge (1956, p. 174) both state that Linnaeus did not have a specimen of *plicatum*, that the descriptions in 1758 and 1767 are not diagnostic, that the figure references are a mixture of several species, and that the only recourse is to consider it a *species dubia*. In this I concur, and follow Dillwyn (1817) and Wood (1818, 1825) in using the earliest valid name, *Buccinum fimbria* Gmelin, 1791, for our species here. The unwarranted use of *plicatum* Linné for this species is attributed to Deshayes' specious arguments (1844). He was followed by Reeve (1848) and Tryon (1885) and by the "rule of popularity" the name *plicatum* was carried on by Bayer (1935), Walter F. Webb and Maxwell Smith.

Types—It is possible that Gmelin did not have a specimen. No type locality was given. We here-

by designate Trincomalee, Ceylon, as the type locality. We suggest that Seba, vol. 3, pl. 53, no. 1, serve as the "type figure".

Records—PORTUGUESE EAST AFRICA: Mozambique City; Porto Amelia (both *vide* K. J. Grosch, 1968). INDIAN OCEAN IDS.: Seychelles (Lienard, 1877, p. 75); Cargados Ids. (Mauritius Inst.); Chagos Ids. (Melvill, 1909, vol. 2, pt. 7, p. 100) CEYLON: Trincomalee (George and Mary Kline, ANSP). THAILAND: Phuket Id., Bay of Bengal (S. Vadavilai, ANSP). INDONESIA: Djakarta and Tjilatjap, Java Id.; Amboina, Ambon Id. (all Rijksmus. Nat. Hist. Leiden); Djumiang, Madura Id., Java Id., and Wijnkoopsbaai, Java Id. (both Mus. Zool. Bogoriense); Moluccas (Manchester Mus.).

Fossil records—None reported.

Phalium darchiaci (Noetling, 1895)

(Pl. 71)

Range—Oligocene of Minbu, Burma.

Remarks—This distinctive fossil species is probably a forerunner of the Recent *Phalium fimbria* Gmelin. The shell is about one inch in length, has the dorso-ventral flattening of *Phalium*, has four former varices in the spire, has a strongly beaded subsutural cord, and has a series of longitudinally compressed, axial nodules on the last whorl which might have, in later geological times, given rise to the curious axial plications found in the Recent *P. fimbria*. Noetling (1895, p. 27) stated that the fossil fragment illustrated by d'Archiac and Haime in 1854 (Deser. des Anim. Fossiles du Group Nummulitique de l'Inde, pl. 31, fig. 1) was this species, but this is questionable. The original description reads:

The species name was originally spelled "*d'archiaci*", but according to the International Commission, 1961, article 32 c (i), the apostrophe should be dropped. the name should be emended to *darchiaci*. I do not consider this a homonym of *Cassis archiaci* Bellardi, 1851. Therefore, Vredenburg's 1921 replacement name of *Cassidea birmanica* is superfluous.

Synonymy—

- 1895 *Cassis d'archiaci* Noetling, Memoirs Geol. Survey India, vol. 27, pt. 1, p. 27, pl. 6, figs. 1, la, lb (Minbu); 1901. Palaeontologia Indica, new series, vol. 1, p. 294, pl. 19, figs. 14a-c (zone of *Cancellaria martiniana*, Minbu).
 1921 *Cassidea birmanica* Vredenburg, Records Geol. Survey India, vol. 51, pt. 3, pp. 269, 290 (Minbu and Singu; Oligocene).

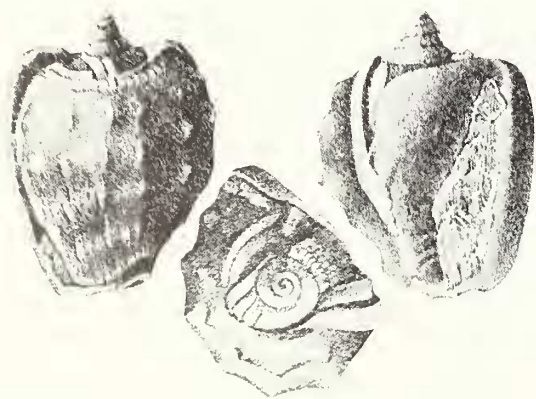


Plate 71. *Phalium darchiaci* (Noetling, 1895). Miocene of Upper Burma. Holotype. 28 mm. in length.

1926, there was known only one gastropod from the Tertiary of Oregon with the name *dalli*, namely *Galeodea dalli* Dickerson, 1917, which had "Dolium-like" characters, and to which Howe was most certainly referring. It probably makes little difference whether or not this name is validly introduced, since it is based upon a poorly described, imperfect specimen. The type appears to have characters very close to those of *Echinophoria*, and for this reason I am burying *Trachydolium* in the synonymy of Sacco's earlier genus. *Miogalea* Woodring and Olsson, 1957, was based upon *dalli* Anderson (= *andersoni* Abbott, 1968), and is considered a subjective synonym of *Echinophoria*.

Subgenus *Echinophoria* Sacco, 1890

Type: *Buccinum intermedium* Brocchi, 1814

Members of this subgenus are characterized by a thin, raised strong thread running along the dorsal surface of the outside of the siphonal canal. It emerges from within the umbilicus and ends at the edge of the siphonal notch. In general, the shells are relatively light in weight, usually white or gray, commonly with small tubercles on the shoulder of the last whorl, always with numerous spiral microscopic threads on the outer surface, and rarely having weak teeth on the white reflected outer lip.

This subgenus had many Tertiary species in Europe and the East Indies. Today, a few widely scattered species live mainly in deep water. The operculum is oval to fan-shaped, horny, and smooth.

The genera *Euspinocassis* Finlay, 1926, and *Shichiheia* Hatai and Nisiyama, 1949, are based upon species with unusually prominent sculpturing.

The name *Echinophoria* should not be confused with *Echinophora* Latreille, 1825, which is a synonym of *Galeodea* Link, 1807 (with type *echinophora* Linné).

Nomenclature—There is some doubt as to the validity of Howe's introduction of the generic name *Trachydolium*. Tegland (1931, p. 415) considered the name a *nomen nudum*. I consider it validly, but inadvisedly, introduced. Howe, (1926, p. 303), in discussing Oligocene mollusks of Oregon, proposed "*Trachydolium*, new genus." On page 305 he lists only one species, namely *Trachydolium dalli*, which would be its type by monotypy. Throughout Howe's article many well-known previously described species are mentioned, but without their authors. In

Synonymy—

- 1890 *Echinophoria* Sacco, Molluschi dei terreni terziarii del Piemonte e della Liguria, pt. 7, p. 39 [not *Echinophora* Leske, 1778, a different name]. (type *intermedia* Brocchi, 1814, by Dall's subsequent designation); 1931, Rutsch, Eclogae Geol. Helvetiae, vol. 24, p. 251.
- 1926 *Trachydolium* Howe, Pan-American Geologist, vol. 45, no. 4, p. 303, 305 (type by monotypy: *T. dalli* [Dickerson, 1917]).
- 1926 *Euspinocassis* Finlay, Trans. and Proc. New Zealand Inst., vol. 56, p. 230 (type by Powell's 1928, p. 631, subsequent designation: *E. pollens* Finlay).
- 1949 *Shichiheia* Hatai and Nisiyama, Jour. Paleontology, vol. 23, pt. 1, p. 93 (type by original designation: *S. etchusenensis* Hatai and Nisiyama, 1949. Miocene; Japan).
- 1957 *Bathygalea* Woodring and Olsson, U.S. Geol. Survey, Prof. Paper 314-B, p. 22. Type by original designation: *Cassis coronadoi* Crosse, 1867.
- 1957 *Miogalea* Woodring and Olsson, *loc. cit.*, p. 22. (Type by original designation: *Cassis dalli* Anderson. Miocene).

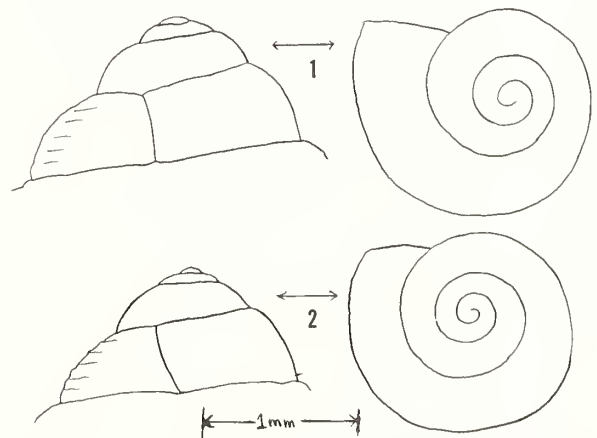


Plate 72. Nuclear whorls of (fig. 1) *Phalium* (*Echinophoria*) *pilsbryi* (Woodring and Olsson) and (fig. 2) *P.* (*Echinophoria*) *trituberculata* (Weaver).

***Phalium intermedium* (Brocchi, 1814)**

(Pls. 73, 74)

Range—Oligocene and Miocene of Italy.

Remarks—This is the type of the subgenus *Echinophoria* Sacco. We reproduce the photograph of the lectotype published by Ronchetti in 1953. A large number of minor forms were described by Sacco.

Synonymy—

- 1814 *Buccinum intermedium* Brocchi, *Conchiologia Fossile Subapennina*, vol. 2, p. 327 (Piacentino).
 1817 *Cassis rotundata* DeFrance, *Diction. Sci. Naturelle*, vol. 7, p. 211. Non Perry, 1811.
 1826 *Cassidaria tuberculata* Risso, *Hist. Nat. Europe Mérid.*, vol. 4, p. 186. Non *Cassidea tuberculata* G. Fischer, 1807.
 1841 *Cassis quadricincta* Bonelli (MSS), Bellardi and Michelotti, *Memorie della Reale Accad. Scienze Torino*, ser. 2, vol. 3, p. 146 (in synonymy of *variabilis*).
 1841 *Cassis variabilis* Bellardi and Michelotti, *Memorie della Reale Accad. Scienze Torino*, ser. 2, vol. 3, p. 146 (Colle di Torino, Italy).
 1877 *Cassis variabilis* var. *tuberosa* Locard, *Annales Soc. Agri. Hist. Nat.*, Lyon, ser. 4, vol. 9, p. 60, pl. 4, fig. 5, 6 (Casabianda, Corsica). Non Röding, 1798.
 1890 *Echinophoria variabilis* Bell. and Mich., Sacco, *I Molluschi dei Terreni Terziarii Piemonte Liguria*, pt. 7, p. 43, pl. 1, fig. 43 (Colli torinesi).
 1890 *Echinophoria variabilis* subvar. *miodenticulata* Sacco; subvar. *elongata* Sacco; subvar. *ampliseriata* Sacco; var. *costata* var. *basicostata* Sacco; var. *transiens* Sacco, all *loc. cit.*, pp. 44-45, pl. 1, figs. 44-46; vars. *unocincta*, *bicincta*, *tricincta*, *quatuorcincta* "Bell. and Micht." Sacco, *loc. cit.*, p. 45.
 1890 *Echinophoria pliorondoletii* Sacco, *loc. cit.*, p. 43, pl. 1, fig. 42 (Zinola).
 1890 *Echinophoria intermedia* subvar. *acutitubercula*; subvar. *fasciata*; subvar. *paucidentata*; subvar. *depressa*; subvar. *plioelegans*; var. *subvariabilis* (pl. 1, fig. 47); var. *mioelegans* (pl. 1, fig. 48); var. *stazzanensis* (pl. 1, fig. 49); subvar. *herculea*; var. *subtriseriata* all Sacco, *loc. cit.*, pp. 46-50; var. *tricincta* [sic] "Bell. and Micht.", var. *quinquecincta* "Bell. and Micht." both Sacco, *loc. cit.*, p. 49.



Plate 73. *Phalium (Echinophoria) intermedium* (Brocchi, 1814). Italian Tertiary. Length: 47.6 mm. Lectotype (from Ronchetti, 1953, p. 168, fig. 87). Type of the subgenus *Echinophoria* Sacco, 1890.



Plate 74. *Phalium (Echinophoria) intermedium* (Brocchi, 1814). Variations in specimens from the Pliocene of Italy.

40-49 mm. in length. (from Sacco, 1904, pl. 20, figs. 25-29).

- 1890 *Echinophoria rondeletii* var. *taurinensis* Sacco (pl. 1, fig. 41); subvar. *colligens* Sacco; subvar. *latiseriata* Sacco, *loc. cit.*, p. 42; 1935, Montanaro, *Paleontographia Italica*, vol. 35, p. 209, pl. 17, fig. 13 (Miocene: Trentino, Italy).
- ?1890 *Echinophoria isseli* Sacco, *loc. cit.*, p. 40, pl. 1, fig. 18 (Oligocene).
- 1940 *Echinophoria intermedia* var. *andreasi* and var. *retifera* Noszky, *Annales Historico-Naturales Muesi Nation. Hungarici*, Budapest, vol. 33, p. 20, pl. 1, fig. 22.
- 1953 *Semicassis* (*Echinophoria*) *intermedia* Brocchi; Ronchetti, *Rivista Italiana di Paleontologia e Stratigrafia*, vol. 59, no. 3, p. 168, fig. 87 (lectotype).

Phalium rondeleti (Basterot, 1825)

(Pls. 75-77)

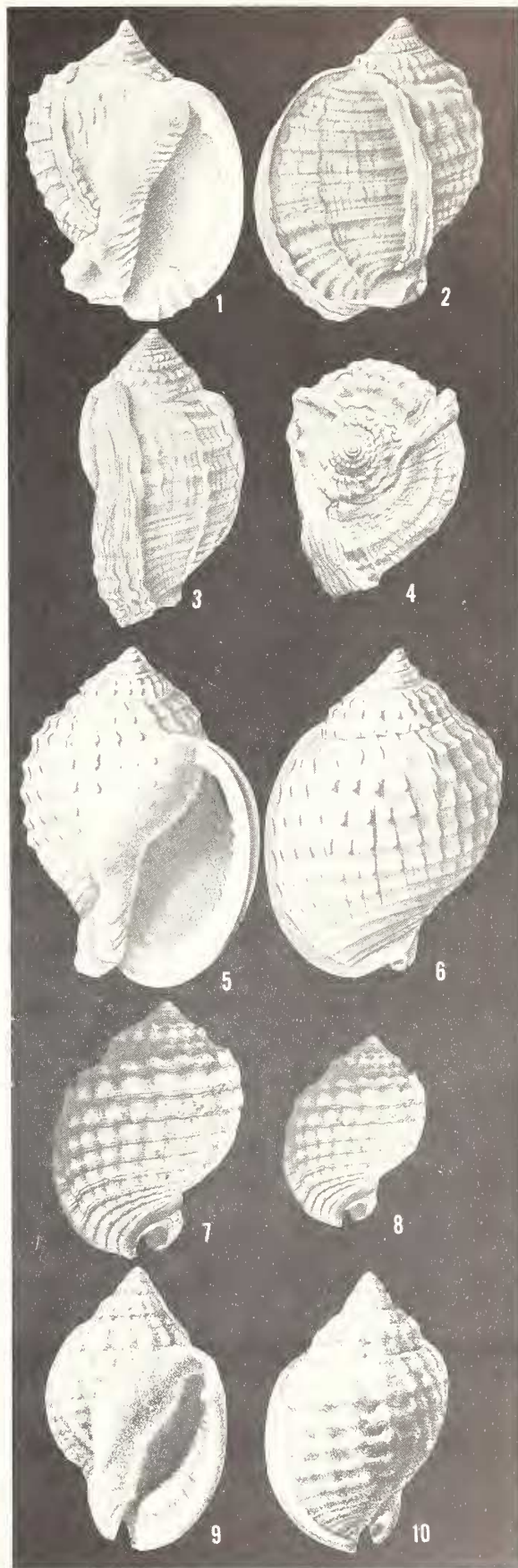
Range—Upper Oligocene and Miocene of northern Europe.

Remarks—This is a well-known and variable *Phalium* of the Tertiary of Europe which has received a number of names.

Synonymy—

- 1825 *Cassis rondeleti* Basterot, *Mémoires Soc. Hist. Nat. Paris*, vol. 2, pt. 1, p. 51, pl. 3, fig. 22, pl. 4, fig. 13; 1840, Grateloup, *Conchyliologie Fossile*. . . l'Adour Bordeaux, Atlas, vol. 1, pl. 34, fig. 12; 1863, Speyer, *Die Conchyl. Casseler Tertiärbild.*, vol. 1, p. 288, pl. 35, figs. 6; 1907, Ravn, *Det König Danske Vidensk. Selskabs Skrifter*, Copenhagen, ser. 7, vol. 3, no. 2, p. 307, pl. 4, fig. 9 (Jutland).
- ?1825 *Cassis nodosa* König, *Icones fossilium sectiles*, pl. 17, fig. 209 (name and figure only).
- 1861 *Cassis aequinodosa* "Sandberger" Michelotti, *Naturkundige Verhandelingen Hollandsche Maatsch. Wetenschappen Haarlem*, ser. 2, vol. 15, p. 133 (Dego, Mayence; Miocene infér.).
- 1863 *Cassis subventricosa* Speyer, *Die Conchylien der Casseler Tertiärbildungen*, Cassel, vol. 1, p. 50, pl. 4, fig. 14, pl. 5, fig. 8a, b.
- 1863 *Cassis sandbergeri* Speyer, *loc. cit.*, vol. 1, p. 52, pl. 4, figs. 13a, b; pl. 5, figs. 2a-d, 3a.
- 1863 *Cassis multinodosa* Speyer, *loc. cit.*, on pl. 5, figs. 4, 4b.
- 1863 *Cassis elongata* Speyer, *loc. cit.*, p. 54, pl. 5, figs. 6, 7.
- 1863 *Cassis crassinodosa* Speyer, *loc. cit.*, p. 56, pl. 5, figs. 5, 9.
- 1863 *Cassis hertha* "Semper", Speyer, *loc. cit.*, p. 52, 54 (nude name).
- 1863 *Cassis aequinodosa* Sandberger, *Die Conchylien Mainzer Tertiärbeckens*, Wiesbaden, p. 193, pl. 19, figs. 8, 8a (Weinheim near Alzei).
- ?1870 *Cassis vicentina* Fuchs, *Denkschriften der Kaiserlichen Akademie der Wissenschaften, Math.-Nat. Classe*, Wien, vol. 30, p. 148, pl. 1, fig. 5, 6 (Eocene of Vicentin).

Plate 75. *Phalium* (*Echinophoria*) *rondeleti* (Basterot, 1825). Miocene of northern Europe. Figs. 1-4, Miocene of Germany. 48 mm. (from O. Speyer, 1863, vol. 1, pl. 35, figs. 6 a-c). Figs. 5, 6, northern Germany. 50 mm. (from Beyrich, 1854, pl. 10, figs. 4 a, b). Figs. 7, 8, Miocene of Europe. 38 mm. (from Cossmann, 1904, pl. 5, figs. 13). Figs. 9, 10, holotype of *Cassis rondeleti aequinodosa* Sandberger, 1863.



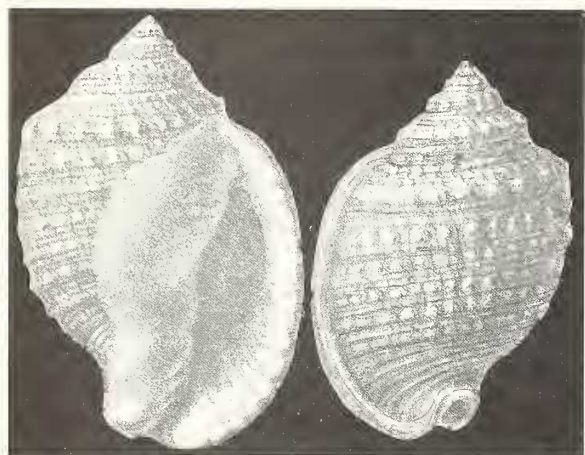


Plate 76. *Phalium* (*Echinophoria*) *scabrida* (Fuchs, 1870). Tertiary of Italy. Holotype, 42 mm. A form or synonym of *rondeleti* (Basterot, 1825).

- ?1870 *Cassis foveolatus* Fuchs, 1870, *ibid.*, p. 214, explanation to pl. 1, figs. 5, 6.
 ?1870 *Cassis scabrida* Fuchs, *ibid.*, p. 203, pl. 8, figs. 31, 32 (Gnata, near Salcedo; Tertiary).
 1890 *Echinophoria rondeletii* var. *apenninica* Sacco, I Molluschi Terreni Terziarii Piemonte, pt. 7, p. 41, pl. 1, fig. 40 (Tongriano: Dego, Carcare; etc.; Oligocene).
 1903 *Cassidea* (*Semicassis*) *rondeleti* Bast., Cossmann, Essais Paléconchologie Comparée, vol. 5, p. 126, pl. 5, fig. 13.
 1907 *Cassis rondeleti* Basterot, Ravn, Det. Kgl. Danske Videnskabernes Selskabs Skrifter, ser. 7, vol. 3, no. 2, p. 307, pl. 4, fig. 9 (Upper Oligocene, Jutland, Denmark).
 1924 *Semicassis* (*Echinophoria*) *rondeleti* Basterot, Cossmann and Peyrot, Actes Société Linnéenne Bordeaux, vol. 75, p. 85, pl. 12, figs. 16, 17 (Burdigalien, France).
 1940 *Echinophoria rondeletii* Bast. var. *longinodosa* Noszky, Annales Historico-Naturales Musei Nation. Hungarici, vol. 33, p. 19.

Phalium megapolitanum (Beyrich, 1854)

(Pl. 78)

Range—Oligocene of Denmark and Germany.

Remarks—This Oligocene species is extremely close to *rondeleti*, but has been kept separate by Ravn (1907) and Glibert (1963).

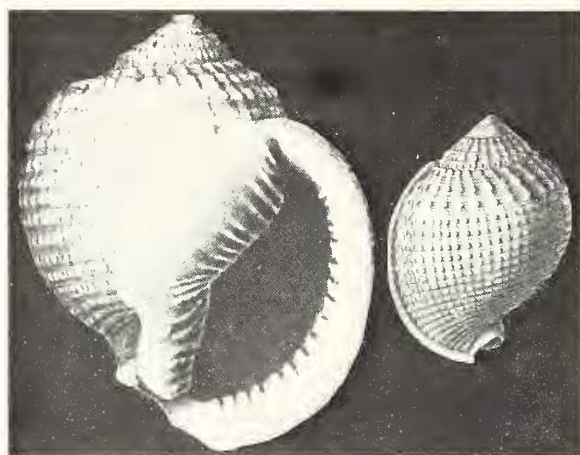


Plate 78. *Phalium* (*Echinophoria*) *megapolitanum* (Beyrich, 1854). **Left fig.**, Oligocene from Denmark. 55 mm. (from Ravn, 1907, vol. 3, pl. 4, fig. 8). **Right fig.**, holotype, from Tertiary of northern Germany. 40 mm. in length. (from Beyrich, 1854, pl. 10, fig. 7).

Synonymy—

- 1854 *Cassis megapolitanum* Beyrich, Zeitschrift der deutsch. geol. Gesell., vol. 6, p. 154, pl. 10, figs. 7, 8; 1907, Ravn, Det. Kgl. Danske Videnskabernes Selskabs Skrifter, ser. 7, vol. 3, p. 308, pl. 4, fig. 8 (Upper Oligocene to Upper Miocene, Denmark).
 1963 *Semicassis megapolitana* Beyrich, Glibert, Institut Royal Sci. Natur. Belgique, Memoires, ser. 2, fasc. 73, p. 110 (Sternberg, Germany; Chattien, Oligocene).

Phalium cancellatum (von Buch, 1831)

Range—Oligocene of northeast Germany.

Remarks—This is very similar to *rondeleti* Basterot, 1825, and may be a synonym or subspecies of it. It appears to have a more delicate sculpture and the columellar shield is not well-developed, suggesting an immature specimen. The name is not preoccupied by the secondary homonym, *Cassidaria cancellata* Lamarck, 1822. Röding's 1798 "*Cassis cancellata*" is a synonym of *Phalium decussatum* Linné, 1758, and is considered a *nomen oblitum*.

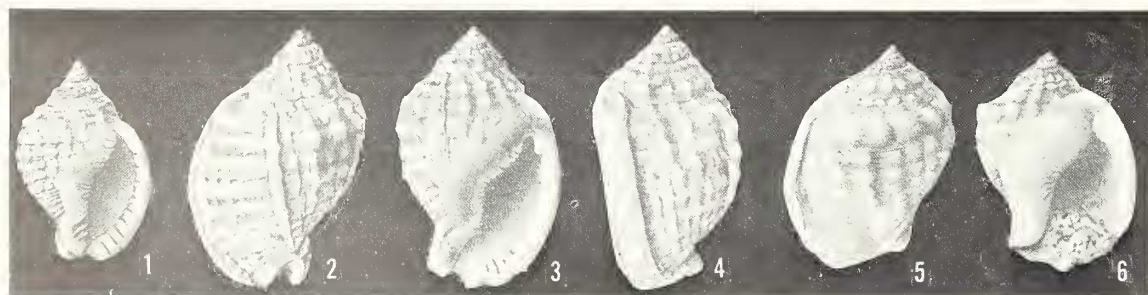


Plate 77. *Phalium* (*Echinophoria*) *rondeleti* (Basterot, 1825). Forma or subspecies from the Miocene of Germany. **Fig. 1**, holotype of *Cassis sandbergeri* Speyer, 1863. 40 mm. **Figs. 2-4**, holotype of *Cassis elongata* Speyer, 1863. 39 mm. **Figs. 5, 6**, holotype of *Cassis crassinodosa* Speyer, 1863. 33 mm.

Synonymy—

- 1831 *Cassidaria cancellata* von Buch, Abhandlungen König. Akademie Wissenschaften Berlin, for 1828, p. 63, pl. 4, figs. 1-4 (Tertiary of Mecklenburg, Germany; Oligocene).

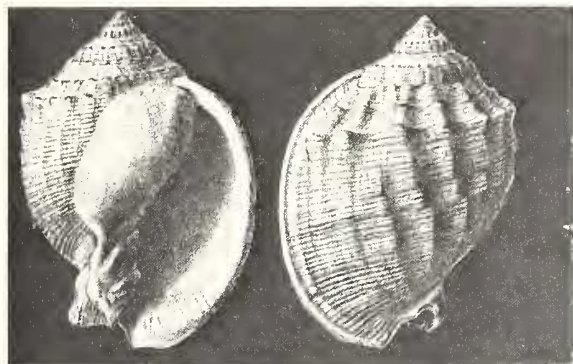


Plate 79. *Phalium (Echinophoria) haueri* (Hoernes and Auinger, 1884). Miocene of Austria. Holotype. 44 mm. in length.

***Phalium haueri* (Hoernes and Auinger, 1884)**

(Pl. 79)

Range—Miocene of Austria.

Synonymy—

- 1848 *Cassis haueri* M. Hoernes, Verzeichniss in Czjzek's Erläuter. z. geogn. Karte von Wien, p. 18, no. 165. (nude name).
 1853 *Cassis variabilis* Bell. and Micht., M. Hoernes, Foss. Moll. Tert.-Beck von Wien, vol. 1, p. 176, pl. 15, fig. 9.
 1884 *Cassis (Cassidea) haueri* M. Hoernes, R. Hoernes and Auinger, Abhandlungen der K. K. Geologischen Reichsanstalt, Wien, vol. 12, pt. 4, p. 158, pl. 17, fig. 13 (Lapugy).

***Phalium coronadoi* (Crosse, 1867)**

A number of marine mollusk species live today in both the Caribbean and Indo-Pacific region. Specimens from these widely displaced areas are not separable, as for example those of *Cynatium nicobaricum* Röding and *Tonna galea* (Linné), while others are only sufficiently different, even in minute details, to justify the acceptance of subspecies. *Phalium coronadoi*, originally described from the West Indies, is extremely similar to *wyvillei* of the Western Pacific, and, at best, the latter can only be considered a subspecies. I am excluding the Pliocene Indonesian species, *bituminatum* (K. Martin) from this species because of the strong spiral bands of knobs which beset its entire body whorl; I also exclude the Recent Galapagos *P. pilsbryi* because of the strong, numerous ridges on the center of the columella. Both species, however, are undoubtedly closely related to *coronadoi*.

Phalium coronadoi***subspecies coronadoi* (Crosse, 1867)**

Range—Southeast United States and the Greater Antilles; deepwater Recent.

Remarks—This large deep-water species is known, so far, from only off North Carolina and Matanzas, Cuba. It doubtlessly occurs in the intervening areas and the Caribbean region in general. The 3½ to 4½ inch long shell has three rows of tubercles on the last half of the body whorl, and the spiral sculpturing appears to be much stronger than in the Indo-Pacific subspecies, *wyvillei*. The differences between the Caribbean and Indo-Pacific forms are not as real as Watson (1886) and Woodring and Olsson (1957) claim. Specimens from Indonesia and Japan show spire heights, regularity of nodules, size and coloration closely approximating those of *coronadoi*. The first postnuclear whorls in both races have 5 or 6 spiral threads. The North Carolina specimen is only ½ inch longer than one from Japan. The spire angles vary from 89° to 105° in *wyvillei*, while in *coronadoi* they are 100° to 102°, indicating that this is probably not a characteristic feature.

Description—Adult 88 to 117 mm. (about 3½ to 4½ inches) in length, globose, moderately thin-shelled, with small knobs on the shouldered whorls of the spire; umbilicate; whitish gray and with a tan periostracum. Nuclear whorls about 3, followed by spiral sculpturing of 6 to 17 fine threads. Body whorl bearing 9 blunt knobs on the shoulder, and 3 low swellings with obsolete knobs below. Interior of outer lip weakly undulate. Last whorl with numerous, flat-topped, spiral threads. Columellar shield moderately broad and white. Columella irregularly folded. False umbilicus slit-like. True umbilicus narrow and deep. Operculum shaped like a broadly opened fan, chitinous, brownish tan and with weak concentric striae on the exterior side.

Measurements—

length	width	no. whorls	angle of spire	
117.0	82.0	8	102°	off North Carolina
99.0	85.0	8	100°	holotype, Cuba
88.0	63.5	8	100°	off Cape Fear, N.C.

Synonymy—

- 1867 *Cassis coronadoi* Crosse, Jour. de Conchyliologie, vol. 15, p. 64, pl. 4, fig. 1, pl. 5, fig. 1 (Matanzas, insulae Cubae).
 1886 *Cassis (Bezardica) coronadoi* Crosse, Watson, Challenger Report, Zoology, vol. 15, p. 409.

1889 *Gaieodea coronadoi* (Crosse), Dall, Bull. 18, Mus. Comparative Zool., Harvard College, p. 231 (off Cape Fear, North Carolina); 1944, Clench, Johnsonia, vol. 1, no. 16, p. 4, pl. 2.

1957 *Bathygalea (Bathygalea) coronadoi* (Crosse), Woodring and Olsson, U.S. Geol. Survey Prof. Paper, 314-B, p. 24, pl. 9, figs. 2, 3.

Records—CUBA: Matanzas Bay, Cuba (type locality). NORTH CAROLINA: 124 fms. (227 meters), 40 mi. off Cape Fear, Blake sta. 2603 (USNM); 18-20 fms. Wimble Shoals, off Cape Fear (N.C. Inst. Fish. Research, No. 274).



Plate 80. *Phalium (Echinophoria) coronadoi* subspecies *wyvillei* (Watson, 1886). 100-155 fms. off Tablas Island, Philippines. Holotype. 99 mm. British Museum (Natural History).

Phalium coronadoi
subspecies wyvillei (Watson, 1886)

(Pls. 80-82)

Range—Japan to Australia at depths of 100 to 567 meters.

Remarks—To date, this subspecies has been recorded from seven Western Pacific localities. This deep-water subspecies is very variable in shape, size and sculpturing, and its differences from *coronadoi coronadoi* from the Caribbean are very slight indeed. Comparative remarks are given above.

Description—Adult from 99 to 117 mm., about $3\frac{3}{4}$ to 4 inches in length, globose, moderately light-weight, but strong; umbilicate; with fine spiral threads and a row of low spines on the shoulder. The last whorl may be smooth or bear one or two rows of nodules. Nuclear whorls 3, bulimoid and white. Parietal wall rarely shows a third row of 3 or 4 glazed-over nodes. Varix strong, recurved, smoothish, enamel-white, flaring below and bearing 5 or 6 almost obsolete lirae on the inner edge of the lip. Body-whorl smooth or with numerous, fine, squared-topped threads. Knobs on shoulder variable in size and number. Color yellowish tan to grayish white; rarely rust-stained.

Columella broad, somewhat distorted, white, partially obscuring the deep, narrow umbilicus, and swollen in the middle; lower half may have 2 or 3 lirae. Siphonal notch deep and rather broad. Top of canal with a fine spiral thread. Gutter posterior to siphonal canal moderately deep and rounded in cross-section. Operculum light-or dark-brown, with concentric growth striae. Operculum 27 mm.; aperture of shell, 47 mm.



Plate 81. Operculum of *Phalium (Echinophoria) coronadoi* subspecies *wyvillei* (Watson, 1886). Off Mikawa, Ishikawa Prefecture, Japan. 39.5 mm.

Tentacles cream and with a single, longitudinal, black line on the dorsal surface. Odontophore with about 120 transverse rows of teeth. Formula: 4-1-4; 7; 4 and 1. The center cusp of the rachidian is tri-cusped in the one animal examined from Indonesia.

Measurements (mm.)—

length	width	no. whorls	angle of spire	
102.0	74.0	8+	105°	Japan
99.0	64.8	9	89°	holotype, Brit. Mus.
(Woodring and Olsson measurements of type inaccurate)				
94.3	66.5	8+	90°	Japan (with 3 varices)
79.5	53.3	8+	90°	Indonesia, Copen. Mus.
75.6	52.8	9	93°	Philippines, USNM
62.7	47.5	9	92°	Philippines, USNM

Synonymy—

- 1886 *Cassis (Bezoardica) wyvillei* Watson, *Challenger* Report, Zoology, vol. 15, p. 408, pl. 14, fig. 13 (Sta. 204A, 100-155 fms. off Tablas Id., Philippines. Type in Brit. Mus.).
- 1944 *Galeodea wyvillei* Watson, *Clench, Johnsonia*, vol. 1, no. 16, p. 4.
- 1957 *Bathygalea (Bathygalea) wyvillei* (Watson), Woodring and Olsson, U.S. Geol. Survey Prof. Paper, 314-B, p. 24, pl. 9, figs. 1, 4; pl. 10, figs. 3, 4 (Philippines).
- 1960 *Echinophoria wyvillei dolium* Kuroda (MS), Azuma, A Catalogue . . . Mollusca . . . Shikoku, Japan, p. 30, pl. 1, fig. 7 (nomen nudum).
- 1962 *Echinophoria wyvillei* (Watson), Habe, Coloured Illus. Shells of Japan, Osaka, vol. 2, p. 44, pl. 21, fig. 10 (200-500 meters, off Japan).

*Records—*JAPAN: off Mikawa, Ishikawa Pref., Honshu Id., 100 meters (T. Habe). PHILIPPINES: 310 fms. (567 meters), between Cebu and Siquijor, *Albatross* Sta. 5535; 182 fms. (333 meters) off N.W. Mindanao Id., *Albatross* Sta. 5519 (both USNM); 100-115 fms. (183-210 meters), off Tablas Id., green mud, *Challenger* Sta. 204a. (Brit. Mus.). INDONESIA: 300 meters, 40 mi. N.W. of Kep Kai Ids., Banda Sea. Th. Mortensen Sta. 8 (Zool. Mus. Copen.). SOLOMON ISLANDS: (Australian Mus.). AUSTRALIA: from fishtrap, 60-80 fms., off North Solitary Id., Wooli, New South Wales (fide Tom Garrard, *in litt.*, 1963).

Phalium pilsbryi (Woodring and Olsson, 1957)

(Pl. 83)

*Range—*Galapagos Islands, shallow water, Recent.

*Remarks—*This species is known only from the type specimen. The shell was picked up on the beach at Seymour Bay, but may originally have come from moderately deep water. The shell is extremely close to that of *P. wyvillei*, differing only in having finer spiral threads and no axial threads in the early post-nuclear whorls, in having a slightly larger umbilicus, and in having a straighter, heavier columella bearing stronger spiral teeth. This latter feature justifies, I believe, retaining *pilsbryi* as a species, although additional material from intervening areas may show a much closer relationship with *wyvillei*. The shell, as a whole, is not thicker than some specimens of *wyvillei*, and the weak denticulations on the inside of the outer lip are probably not very significant.

*Description (of the holotype)—*Adult shell 66.3 mm. (about 2½ inches) in length. Globose, moderately thick shell, with noduled shoulders, umbilicate, and colored a grayish white. Whorls 8. Nuclear whorls bulimoid, relatively large, four in number, smooth, glossy and slightly tilted, and with a weak break just before the post-nuclear whorls. First post-nuclear whorl with about 8 fine, smooth, spiral threads, increasing to 17 by the penultimate whorl. Midway between the irregularly impressed sutures small white knobs are developed which gradually increase in size and number 12 on the last whorl. The last third of the last whorl descends rather rapidly. Base of body whorl with numerous slightly wavy, fine, somewhat flat-topped threads. Below the row of nodules on the shoulder on the last whorl there are 3 additional spiral rows bearing 3 or 4 nodules each. True umbilicus open and deep; false umbilicus at the base of the columella is slitlike and deep. The white parietal wall is moderately developed below; the upper end is a mere white glaze over the body-whorl. Above the columella and on the body-whorl there are 2 very small, slanting, short teeth. Inner edge of the columella furrowed by about 12 short spiral teeth, the two lower ones being the largest. Outer lip recurved, thin but strong, and its inner edge bears numerous, very indistinct teeth. Inside of aperture white. Siphonal canal bordered above by a rounded shallow channel, and bearing a single thin thread along the dorsal side of its length. End of siphon-

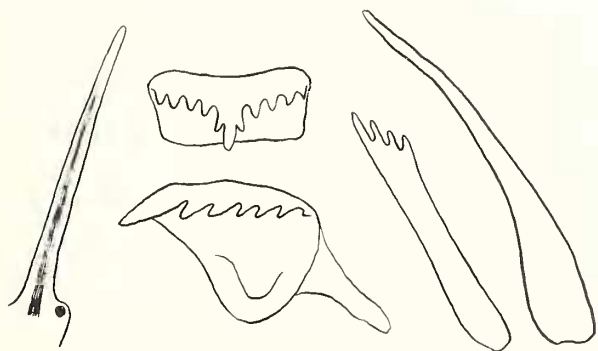


Plate 82. *Phalium (Echinophoria) coronadoi* subspecies *wyvillei* (Watson). Right tentacle and radula of female from the Banda Sea, Indonesia.

al canal deeply notched. Operculum and soft parts unknown.

Measurements (mm.)—

length	width	no. whorls	
66.3	47.0	8	holotype ANSP no. 153618



Plate 83. *Phalium (Echinophoria) pilsbryi* (Woodring and Olsson, 1957). Off Galapagos Islands. Holotype. 66.3 mm. in length.

Synonymy—

- 1957 *Bathygalea (Bathygalea) pilsbryi* Woodring and Olsson, U.S. Geol. Survey Prof. Paper 314-B, p. 24, pl. 10, figs. 1, 2 (Seymour Bay, Indefatigable Island (Isla de Santa Cruz), Galapagos).

*Types and Records—*See under Synonymy. Known only from the type locality.

***Phalium bituminatum* (K. Martin, 1933)**

*Range—*Pliocene, Asphalt beds of Buton Island, Indonesia.

*Remarks—*This species shows such a close resemblance to other members of the subgenus *Echinophoria* that I am assigning it to a position close to *carnosum* Kuroda and Habe, 1961. This species has a lower spire and has more pronounced teeth on the inside of the outer lip than does *carnosum*, but otherwise is strikingly similar. The type is 28.5 mm. in width. Beets' specimen is 36.7 mm. in length.

Synonymy—

- 1933 *Cassidea (Semicassis) bituminata* K. Martin, Leidsche Geol. Mededeel. Leiden, vol. 6, no. 1, pp. 10, 28, pl. 4, fig. 28 (Tertiary, Waisiu, Buton Id., Indonesia).
1943 *Phalium (Semicassis) bituminatum* (Martin) Beets, *loc. cit.*, vol. 13, no. 1, p. 277, pl. 28, fig. 58 (Waisiu, Buton Id.).

***Phalium vandervlerki* (K. Martin, 1933)**

(Pl. 84)

*Range—*Pliocene, Asphalt beds of Buton Island, Indonesia.

*Remarks—*This handsome, 2½-inch-long *Echinophoria* is very close to the Recent deep-water *Phalium wyvillei* Watson, differing only in having two rows (instead of one) of small knobs showing in the penultimate whorl, and in having 6 indistinct (instead of two) spiral rows of nodules showing on the last whorl. The base of the body whorl and the siphonal construction is very close to those in *Phalium pilsbryi* (Woodring and Olsson) from the Recent of the Galapagos. I examined the type in Leiden and was convinced of its close relationship to both the type of *Echinophoria* and other Recent species. K. Martin's paratype (his pl. 4, fig. 28) is another unnamed species. The holotype measures 64 mm. in length, 28.5 mm. in width.

Synonymy—

- 1933 *Cassidea (Semicassis) vandervlerki* K. Martin, Leidsche Geologische Mededeelingen, Leiden, vol. 6, no. 1, pp. 10, 27, pl. 4, fig. 27, 28a (Tertiary, Waisiu, Buton [Boeton] Id., Celebes, Indonesia).



Plate 84. *Phalium (Echinophoria) vandervlerki* (K. Martin, 1933). Tertiary, Waisiu, Indonesia. 64 mm. in length.



Plate 85. *Phalium (Echinophoria) bituberculosum* (von Martens, 1901). 1079 meters, off Somalia. Holotype. 45 mm. in length. (from von Martens, 1903, pl. 3, fig. 11).

Phalium bituberculosum (von Martens, 1901)

(Pl. 85)

Range—Deep-sea off Somalia, East Africa (1079 meters).

Remarks—I have seen only the type of this species which was described from a single specimen dredged in 1079 meters by the "Valdivia". It is a very distinctive shell somewhat resembling *P. inornata* Pilsbry, but is more beaded and has a much smaller umbilicus. The shell appears to be broken at the base of the columella and our placement in the subgenus *Echinophoria* is provisional.

Description—Shell 45 mm. (1¾ inches) in length, ovate, pale grayish white in color, and bearing numerous, irregular spiral threads which are finely tuberculate on the slightly angular shoulder. One former varix present on the penultimate whorl. Outer lip with about 23 irregular teeth. Columella shield poorly developed and obliquely sulcate. Whorls 7. Nuclear whorls 3, white, and smooth. True umbilicus chink-like; false umbilicus closed. Length of shell: 45 mm.; width: 30.1 mm.; length of aperture: 35 mm.

Synonymy—

1901 *Cassis bituberculosa* von Martens, Sitzungsberichte Gesellschaft Naturfor. Freunde Berlin for 1901, p. 23 ("Valdivia" station 264); 1903, Wissenschaft. Ergebn. Deutschen Tiefsee-Exped. "Valdivia", vol. 7, pt. A, p. 111, pl. 3, fig. 11.

Types and Records—Known only from the type locality: about 100 miles N.N.E. of Obbia, Somalia, in 1079 meters, Globigerina ooze. "Valdivia" station 264, N. Lat. 6°18'; E. Long. 49°32'. The holotype is no. 60052 in the Zoological Museum of Humboldt University in Berlin (1962).

Fossil records—None reported.

***Phalium carnosum* (Kuroda and Habe, 1961)**

(Pl. 86)

Range—100-200 fathoms, off central Japan.

Remarks—This 2½-inch, chalky-white *Phalium* (*Echinophoria*), and its closely related *P. kurodai* Abbott, are unique in having a very reduced columellar shield, and hence lack an umbilicus. In the deepsea *P. bituberculosum* (von Martens) from off East Africa, the columellar shield is midway in development between *carnosum* and *coronadoi* (Crosse). Both species are similar to the *Phalium* (*Echinophoria*) *coronadoi* (Crosse) group, but differ in having several rows of prominent, evenly-sized knobs on the body whorl. In *carnosum*, there are usually 6 rows, while in *kurodai* there are only 5, a feature which appears to be constant. *P. carnosum* is further distinguished by the weakly-pustuled columellar pillar, the numerous, minute spiral threads between the rows of knobs, and the absence of the 5 or 6 prickle-like, small teeth on the base of the outer lip.

Description—Adult shell 64 mm. (2½ inches) in length, globular, rather thin-shelled, chalky-white, with a reduced columellar shield, and with 6 rows of rounded knobs. Nuclear whorls 3, bulimoid, white and glossy, but in eroded specimens the nuclear whorls have a tabulate appearance. Postnuclear whorls cancellated by 2 spiral rows of beads, with about 10 smaller, spiral threads, and by fine axial riblets joining the beads. Last whorl with 6 spiral rows of rounded, evenly-sized beads on the upper two-thirds. Base of shell with numerous, fine, raised threads. Upper part of parietal wall with small knobs; columellar shield weakly developed and usually weakly granular and twisted. Outer lip reflected and bearing low, spiral teeth, usually along the entire length. Umbilicus absent. Siphonal canal with a prominent, impressed scar running along the length of its dorsal, outer surface. Color of shell chalky-white, but some specimens with a rose suffusion and a hint of spiral color bands. Operculum chitinous, dark-brown and oval.

***Measurements (mm.)*—**

length	width	no. whorls	
64.5	44.1	8	off Tosa, Japan
62.8	42.5	8	off Tosa, Japan
53.2	34.7	—	holotype

***Synonymy*—**

1960 *Echinophoria carnosa* Kuroda (MS) Azuma, A Catalogue . . . Mollusca . . . Shikoku, Japan, p. 30, pl. 3, fig. 9 (nomen nudum).

1961 *Echinophoria carnosa* Kuroda and Habe, in Habe, Coloured Illus. Shells of Japan, vol. 2, p. 44, pl. 21, fig. 11, and appendix p. 16 (250-300 meters, off Tosa, Japan); 1961, Oyama, The Molluscan Shells, Resources Exploitation Institute, Tokyo, vol. 5, *Echinophoria* plate, figs. 2, 3 and 8 (not 1).

Records—JAPAN: 200 fms., off Tosa, Shikoku Id. (part of type lot from A. R. Cahn coll., ANSP); 170 fms., off Tosa (ANSP); 250-300 meters, off Tosa (Habe, 1961, app. p. 16).

Fossil records—None reported.



Plate 86. *Phalium* (*Echinophoria*) *carnosum* (Kuroda and Habe, 1961). **Top shell:** part of type lot from 200 fathoms, off Tosa Japan; 62.9 mm. in length; ANSP no. 253339. **Bottom figure:** 64.8 mm. in length, 170 fathoms off Tosa, Japan. Both from the Alvin R. Cahn collection at the ANSP.

Phalium kurodai *new species*, Abbott

(Pl. 87)

Range—Tosa Bay, Shikoku Id., Japan.

Remarks—I take pleasure in naming this new species after the distinguished Japanese malacologist, Tokubei Kuroda, who gave it a manuscript name of *galeodiformis* several years ago. This *Echinophoria* is closely related to *carnosum* Kuroda and Habe, but differs in having 5 (instead of 6) spiral rows of knobs on the body whorl, in having a narrower and smoother columellar pillar, in lacking the densely-packed, spiral threads, and in having only one spiral row of nodules in the early whorls of the spire. The lower part of the outer lip has 7 to 10 small, blunt prickles. Neither *kurodai* nor *carnosum* should be confused with the similar-appearing *Galeodea echinophorella* Hirase, 1934, or *Galeodea leucodoma* Dall, 1907, both of which have a slot-less, unrecurved siphonal canal and loosely-coiled nuclear whorls.

Description—Adult shell 56 to 68 mm. (2½ inches) in length, globular, rather thin-shelled, but strong, yellowish white, with a very reduced columellar shield, and with 5 rows of rounded nodules. Nuclear whorls 3, bulimoid, white and glossy, but in eroded specimens the nuclear whorls have a tabulate appearance. Postnuclear whorls with weak, spiral threads, the one midway between the sutures bearing rather large, evenly-sized nodules. Last whorl with 5 spiral rows of whitish, rounded nodules. Base of body whorl smoothish or with very weak spiral threads. Upper part of parietal wall thinly glazed and with 3 rows of nodules. Columellar pillar narrow, glossy white and strongly twisted. Siphonal canal recurved, slotted, and with a thin, narrow, raised line running longitudinally along its dorsal, outer surface. Outer lip slightly recurved and bearing 5 to 12 small, prickle-like teeth on the outer edge of the lower third. Outer lip with weak, brown spots in some specimens which exhibit weak, spiral, narrow bands of brownish orange. Umbilicus absent. Operculum unknown.

Measurements (mm.)—

length	width	no. whorls	
68.0	47.2	7+	holotype, off Tosa, Japan
64.7	42.5	7	paratype, off Tosa, Japan
59.5	40.0	7+	paratype, off Tosa, Japan
57.0	40.0	7+	paratype, off Tosa, Japan

Types—The holotype, originally a gift by Dr. Alvin R. Cahn to the Academy of Natural Sciences of Philadelphia, has been given to the



Plate 87. *Phalium (Echinophoria) kurodai* Abbott *new species*. 120 fathoms, off Tosa Bay, Shikoku Island, Japan. **Top figure:** holotype, 68.0 mm., deposited in the National Science Museum, Tokyo, Japan. **Lower figure:** paratype, 67.5 mm. in length; Tosa Bay, Japan. ANSP no. 253338.

National Museum in Tokyo, Japan. The type locality is 120 fms., Tosa Bay, Shikoku Id., Japan. Four paratypes from 100 fms., Tosa Bay, Japan are in ANSP no. 241694.

Synonymy—

- 1961 *Echinophoria* sp., Oyama, The Molluscan Shells, Resources Exploitation Institute, Tokyo, vol. 5, *Echinophoria* plate, figs. 1, 6 and 7 (not 8).
1960 *Echinophoria galeodiformis* Kuroda (MS) Azuma, A Catalogue . . . Mollusca . . . Shikoku, Japan, p. 30, pl. 3, fig. 10 (nomen nudum).

***Phalium etchuense* (Hatai and Nisiyama, 1949)**

(Pl. 88)

Range—Miocene of Japan.

Remarks—This species closely resembles some of the Tertiary *Echinophoria* of Indonesia and is not unlike the Panamanian Pliocene *hadrum* (Woodring and Olsson, 1957). The single known specimen appears to have been poorly preserved, and has lost its siphonal canal. The genus *Shichiheia*, based upon this species, is not distinguishable from *Echinophoria*.

Description—(from Hatai and Nisiyama, 1949). Shell thin, oval, moderate in size, with six whorls, separated by appressed sutures; the first two nuclear whorls apparently smooth, rounded; spiral sculpture commencing on the third whorl, where six smooth, revolving flat cords, much wider than the interspaces, are found; tuberculation commences with later growth; fifth whorl with about ten primary and about seven secondary spirals, narrower than interspaces; body-whorl with three rows of tubercles and early stage of a fourth row; all whorls roundly shouldered; varix on last whorl fairly strong, extending to columella; callus deposit thin and wide-spread; canal short and twisted, with distinct folds; outer lip crenulated. Height of holotype 39.5 mm., diameter 29.0 mm.

Type locality—Kami-Shin, Kurosedani-Mura, Nei-Gun, Toyama-Ken, Honshu Id., Japan. Susahara formation, Miocene. The holotype is in the Institute of Geology and Palaeontology, Tohoku University, Sendai, no. 72518.

Synonymy—

- 1949 *Shichiheia etchuensis* Hatai and Nisiyama, Jour. Paleontology, vol. 23, pt. 1, p. 94, pl. 24, figs. 1, 2, 7.

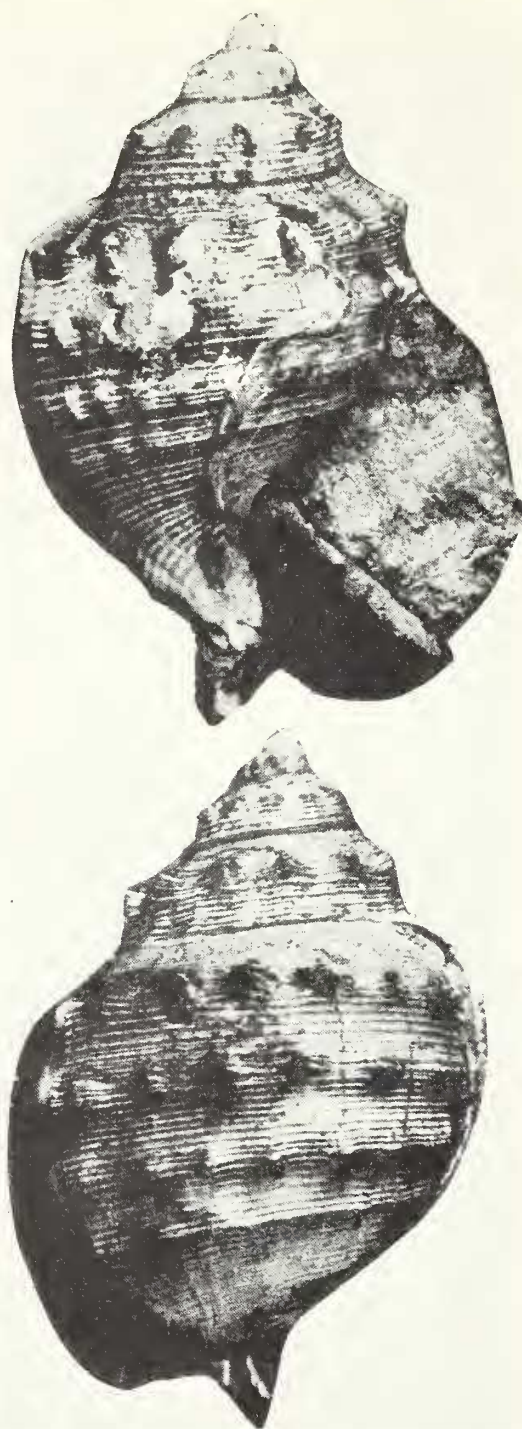


Plate 88. *Phalium* (*Echinophoria*) *etchuense* (Hatai and Nisiyama, 1949). Miocene of Japan. Holotype from Hatai and Nisiyama, 1949. 39.5 mm. in length.

Phalium andersoni new name, Abbott

(Pl. 89, figs. 1, 2)

Range—Early Miocene, Caribbean coast of Colombia.

Remarks—Originally described as *Cassis* (*Phalium*) *dalli* Anderson, 1929, and later made the type of *Bathygalea*'s subgenus *Miogalea* by Woodring and Olsson in 1957, this species undoubtedly belongs in the subgenus *Echinophoria*. This makes *dalli* Anderson, 1929, a secondary homonym of *Phalium dalli* (Dickerson, 1917) from the Oligocene of the Pacific Northwest. I do not consider the smaller size (49 mm.), thicker shell, supposedly more sharply pointed knobs and supposedly stronger spiral sculpturing (all of which can be found in some combination in various *Echinophoria*) sufficiently different to justify the recognition of *Miogalea*. *Phalium hadra* (Woodring and Olsson, 1957) from the early Pliocene of the Caribbean side of Panama was also placed in *Miogalea* by those two authors, but it shows even closer affinities with other fossil *Echinophoria* and some living species, such as *pilsbryi* from the Galapagos.

Description (from Woodring and Olsson, 1957) —“Thick-shelled. Varix on body whorl preceding the terminal varix generally absent, but present on one specimen [an adult]. Body whorl bearing 10 or 11 sharply pointed knobs on shoulder. Three low swellings on body whorl below shoulder bearing low blunt knobs on early part of whorl. Outer lip, parietal callus and shield very thick. Interior of outer lip bearing long straight ridges. Height: 49.5 mm.; diameter: 39.5 mm.”

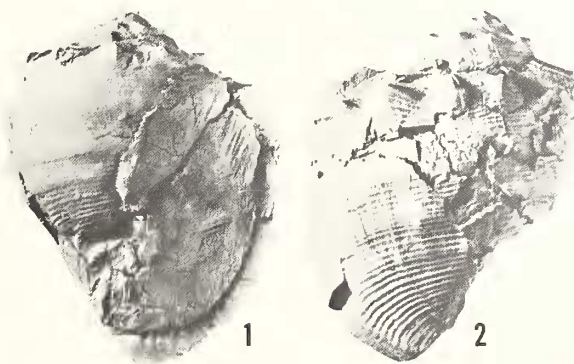


Plate 89. Figs. 1, 2, *Phalium* (*Echinophoria*) *andersoni* Abbott new name, Miocene of Colombia. 49 mm. Figs. 3, 4, *Phalium* (*Echinophoria*) *hadrum* (Woodring and Olsson,

Synonymy—

1929 *Cassis* (*Phalium*) *dalli* Anderson, Proc. Calif. Acad. Sci., 4th series, vol. 18, no. 4, p. 141, pl. 14, figs. 10-13 (one mile or more west of pier at Puerto Colombia, Dept. Atlantico, Colombia, Las Perdices shale; type in Calif. Acad. Sci. no. 4649). Not *Phalium dalli* Dickerson, 1917.

1957 *Bathygalea* (*Miogalea*) *dalli* (Anderson), Woodring and Olsson, U.S. Geol. Survey Prof. Paper, 314-B, p. 23, pl. 7, figs. 1-4; pl. 8, figs. 3, 4 (3.5 mi. west of Puerto Colombia; Olsson locality 294).

Phalium hadrum (Woodring and Olsson, 1957)

(Pl. 89, figs. 3, 4)

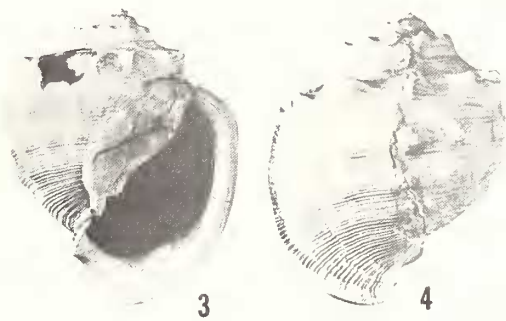
Range—Early Pliocene, Caribbean coast of Panama.

Remarks—This species appears to be quite closely related to *andersoni* Abbott (new name for *dalli* Anderson), but has a thinner shell, correspondingly thinner outer lip, parietal callus and shield, and weaker ridges on the interior of the outer lip. The rows of knobs and fine spiral sculpturing are typically *Echinophoria*.

Description (from the original)—“Moderately thick-shelled. Varices absent, except for terminal varix. Protoconch worn, consisting of about 3 whorls. Body whorl bearing 10 sharply pointed knobs on shoulder. Three low swellings on body whorl below shoulder bearing lower blunt knobs on early two-thirds of whorl. Outer lip moderately thick; its interior bearing short moderately strong ridges. Parietal callus and shield thin. Siphonal canal and siphonal fasciole missing. Insertion of siphonal canal wide. Height: 43.7 mm.; diameter: 33.6 mm. (type).”

Synonymy—

1957 *Bathygalea* (*Miogalea*) *hadra* Woodring and Olsson, U.S. Geol. Survey Prof. Paper, 314-B, p. 23, pl. 8, figs. 1, 2 (USGS 8437, Caribbean coast at mouth of Rio Indio, Colon Province, Panama, Chagres sandstone, early Pliocene. Type in USNM 562268).



1957). Pliocene of Panama. Holotype, 43.7 mm. (all from Woodring and Olsson, 1957, pl. 8).

***Phalium apenes* (Woodring, 1959)**

Range—Late Oligocene of the Canal Zone.

Remarks—This poorly preserved specimen may be a *Tylocassis*, but I am keeping it in *Echinophoria* as originally suggested by Woodring.

Synonymy—

1959 *Semicassis* (*Echinophoria*) *apenes* Woodring, U.S. Geol. Survey Prof. Paper 306-B, p. 198, pl. 26, figs. 11, 17 (. . . Bohio Ridge station, Canal Zone, Late Oligocene).

***Phalium woodringi* (Olsson, 1964)**

(Pl. 90)

Range—Known only from the Pliocene of Ecuador.

Remarks—This species is interesting because it bears small *Tylocassis*-like pustules on the lower part of the parietal shield. The left edge of this shield has a strong U-shaped indentation resembling that found in some Australian *Xenophalium*. Technically, the validity of this new species could be questioned, since the author does not compare it with other known species.

Description (from original)—Of medium size, rather thinly textured, the body whorl roundly inflated so that it forms most of the surface, the spire relatively low, conic, composed of about six whorls, the apical ones corroded except on

the smallest specimens. Varices behind the terminal one absent; former halts in shell growth may show occasionally as deep sharp lines across the face of the whorl. The protoconch is relatively large, naticid, composed of about three closely-wound smooth whorls. The whorls have a small shoulder, a little above the widest section of the body whorl, and are neatly ornamented with small nodes (about 15 on the last whorl); these small nodes present also on the whorls of the spire. Small or medium-sized shells have but a single row of nodes, that on the shoulder, but the larger specimens show a second row just below or round the widest section of the body whorl, this row passing into the suture does not appear on any of the spire whorls; in addition, the whole surface is covered with close, regular, medium-sized, spiral threads. The aperture is semilunate, the outer lip thickened externally by a varix, its edge raised and somewhat reflexed, the inner side of the lip smooth or with faint lirae in its lower part. The parietal wall has a thin, spreading and closely appressed coat of callus, smooth or with weak lirations within; below, the callus coat is thicker, narrower, generally covered by a sprinkling of small denticles and short lirae, and forms a free-edged shelf which overhangs an umbilical-like opening formed by the entrance of the deep, fasciolar groove encircling the small beak. The siphonal canal carries a deep notch, recurved at the end forming a small beak, its growth trace producing a flat fasciole edged by a small, sharp keel.

Height 36.3 mm., diameter 29.4 mm. Que. Camarones. Holotype, USNM 644057; height 38.5 mm., diameter 31.4 mm. Que. Camarones. Paratype, USNM 644058; height 49.7 mm., diameter 37.4 mm. Punta Gorda. Paratype, USNM 644059.

Probably a deep-sea species. It is fairly common in Quebrada Camarones, less so at Punta Gorda. Named as a tribute to Dr. W. P. Woodring, Tertiary Paleontologist of the United States Geological Survey.

Synonymy—

1964 *Echinophoria woodringi* Olsson, Neogene Mollusks from Northwestern Ecuador, Paleo. Research Inst., Ithaca, p. 170, pl. 30, figs. 8, 8a (Quebrada Camarones, Ecuador).



Plate 90. *Phalium* (*Echinophoria*) *woodringi* (Olsson, 1964). Holotype from Quebrada Camarones, Ecuador. Esmeraldas formation, Miocene. Holotype in USNM no. 644057; length: 36.3 mm.

Phalium tuberculiferum (Hupé, 1854)

(Pl. 91, figs. 1-3)

Range—Tertiary of Chile.

Remarks—This species appears to be very close to the Pliocene *Phalium hadrum* Woodring and Olsson, 1957, and the Recent *P. pilsbryi* Woodring and Olsson, 1957. Hupé's specimen lacks a well-developed, lower parietal shield which might indicate a not fully matured individual.

Synonymy—

1854 *Cassidaria tuberculifera* Hupé, in Gay's *Historia física i política de Chile*, Zoologica series, vol. 8, p. 209, Atlas, pl. 3, figs. 2, 2a (Coquimbo, Tertiary).

1887 *Cassis tuberculifera* Hupé, Philippi, *Die Tertiären und Quartären Versteinerungen Chiles*, Leipzig, p. 69, pl. 8, fig. 2 (Navidad, Lebu and Llancahue, Chile).

Phalium taitii (Conrad, 1834)

(Pl. 92)

Range—Eocene of Alabama, Mississippi and Louisiana.

Remarks—This species could be placed in either the subgenus *Echinophoria* or *Semicassis*.

Synonymy—

1834 *Cassis taitii* Conrad, *Jour. Acad. Nat. Sci. Philadelphia*, vol. 7, p. 145 (Claiborne, Alabama; Eocene); 1899, Johnson, *Proc. Acad. Nat. Sci. Philadelphia*, vol. 51, p. 77, pl. 2, fig. 5.

1937 *Phalium taitii* Conrad, Palmer, *Bull. Amer. Paleontology*, vol. 7, no. 32, p. 251, pl. 83, fig. 10.

1947 *Phalium taitii johnsoni* Palmer, *Bull. Amer. Paleontology*, vol. 30, no. 117 (sec. 2), p. 328, pl. 42, figs. 12, 13 (Moody Branch marl, Jackson, Miss.; Eocene).



Plate 92. *Phalium (Echinophoria) taitii* (Conrad, 1834). Eocene of Jackson, Mississippi. C. W. Johnson, leg. 1894. Length: 36 mm. ANSP no. 7083.

Phalium trituberculatum (Weaver, 1912)

(Pl. 93)

Range—Upper Eocene of Washington State and California.

Remarks—This is a well-known, small *Echinophoria* closely resembling the type of the subgenus. It has been amply illustrated by Weaver (1942), Schenck (1926) and Tegland (1931). Apparently this species was first described with a brief description in 1855, and a poor illustration

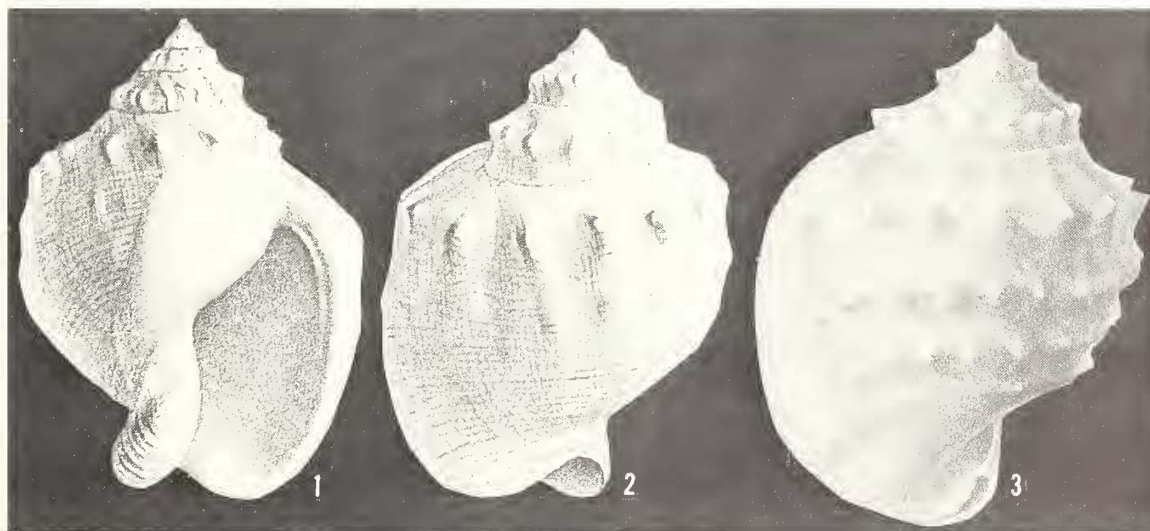


Plate 91. *Phalium (Echinophoria) tuberculiferum* (Hupé, 1854). Tertiary of Chile. Figs. 1, 2, holotype of *Cassidaria*

tuberculifera Hupé. 55 mm. Fig. 3, specimen 54 mm. in length (from Philippi, 1887, pl. 8, fig. 2).

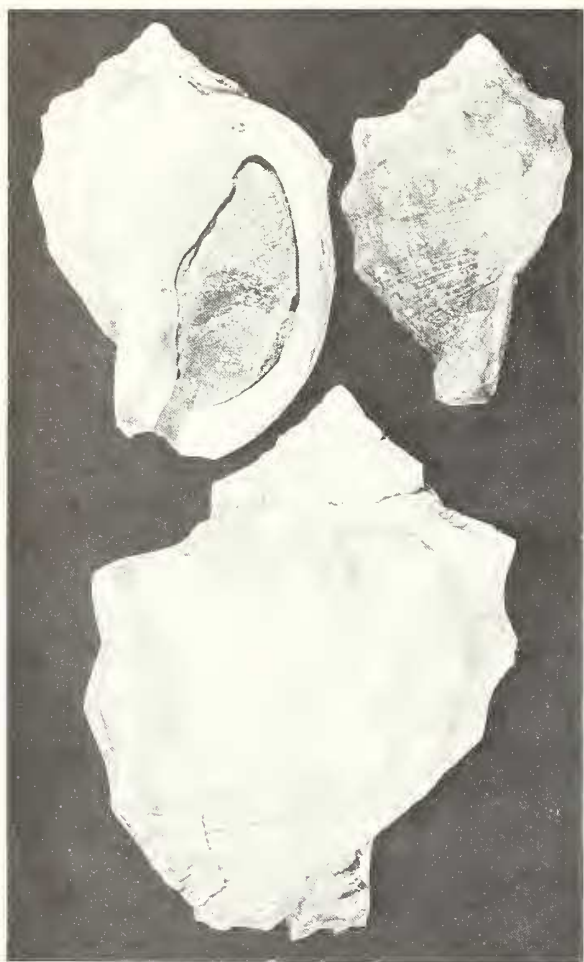


Plate 93. *Phalium* (*Echinophoria*) *trituberculatum* (Weaver, 1912). At bend of Cowlitz River, 1.5 miles east of Vader, Lewis Co., Washington. Walter J. Eyerdam collection.

in 1857 by Conrad as *Stramonita* (*Purpura*) *petrosa*. Schenck (1926) and Anderson and Hanna (1925) concluded, correctly we believe, that Conrad's species is the same as *trituberculata* Weaver, 1912. Conrad's earlier name cannot be used because it is a secondary homonym of *Phalium* (*Manicassis*) *petrosum* (Conrad, 1849).

The four nuclear whorls of *trituberculatum* are smooth, bulimoid and rounded like those of other *Echinophoria*, and not as Weaver and Schenck must have assumed, like *Galeodea*.

Synonymy—

- 1855 *Stramonita petrosa* Conrad, U.S. House Document no. 129, appendix, art. 1, p. 17, 18 (Tulare Valley); 1856, U.S. Pacific Railroad Survey, vol. 5, pt. 2, art. 2, p. 327, no. 48, pl. 6, figs. 47, 47a (Tulare Valley). [Tejon Eocene, south end of San Joaquin Valley, Calif.].

- 1912 *Morio tuberculatus* Gabb var. *tri-tuberculatus* Weaver, Wash. Geol. Survey, Bull. no. 15, pp. 39, 40, pl. 3, figs. 35 (north bank of Cowlitz River, 1.5 mi. east of Vader, Lewis Co., Wash.).
- 1922 *Galeodea tri-tuberculata* (Weaver), Weaver and Palmer, Univ. Wash. Publ. Geol., vol. 1, p. 37, pl. 11, figs. 23, 27; 1925, Anderson and Hanna, Occ. Papers, Calif. Acad. Sci., no. 11, pl. 10, figs. 2, 3; 1931, Tegland, Univ. Calif. Publ. Bull. Dept. Geol. Sci., vol. 19, pp. 408, 409, pls. 59, 60; Weaver, 1942, Univ. Wash. Publ. Geol., vol. 5, p. 404, pls. 78, 79.
- 1926 *Galeodea petrosa* Conrad, 1857 [1855], Schenck, Univ. Calif. Publ. Bull. Dept. Geol. Sci., vol. 16, no. 4, p. 82, pl. 14, figs. 5-11. Not *petrosum* Conrad, 1849.

Phalium dalli (Dickerson, 1917)

Range—Oligocene of Washington State, U.S.A.

Remarks—I have not seen the type of this species, but subsequent to its first poor description, Durham (1944, p. 166; 1942, p. 185) obtained specimens from the Lower Oligocene, Quimper sandstone, Discovery Bay, Jefferson County, Washington. I follow Durham in placing it in *Echinophoria*, although Durham considered *Echinophoria* as a genus, rather than as a subgenus of *Phalium*. Unfortunately, this creates a homonym of *Phalium dalli* (Anderson, 1929). The latter name can be protected, if one wishes to follow Woodring and Olsson's 1957 placement of Anderson's species in *Bathygalea* (*Miogalea*). I consider the latter two generic names as synonyms of *Phalium*, subgenus *Echinophoria*. This is Rutsch's view (1931, p. 251).

Tegland (1931, p. 410) says that this "seems to be a distinct species but too much weight cannot be placed on the specific characters of a single immature shell, and its relation to the Eocene and to other Oligocene species is not clear." *Phalium fax* Tegland may be this species according to Effinger (1938, p. 382).

Although technically debatable, *dalli* Dickerson may be considered the type of *Trachydolium* Howe, 1926.

Synonymy—

- 1917 *Galeodea dalli* Dickerson, Proc. Calif. Acad. Sci., series 4, vol. 7, p. 176, pl. 30, fig. 8a (but not 8b, a portion of the body whorl of *Siphonalia packi* Dickerson, fide Effinger, 1938, p. 382). (Locality 181, near Vader, Lewis Co., Washington, east bank of Cowlitz River; Oligocene); 1931, Tegland, Univ. Calif. Bull. Dept. Geol. Sci., vol. 19, no. 18, p. 410 (Gries Ranch, Wash.); 1938, Effinger, Jour. of Paleontology, vol. 12, no. 4, p. 382 (Gries Ranch).
- 1942 *Echinophoria dalli* (Dickerson), Durham, Jour. of Paleontology, vol. 16, no. 2, p. 185, pl. 29, fig. 4, pl. 30, fig. 5.

Phalium oconnori (Dell, 1952)

Range—Upper Miocene, Hurupi Beds, New Zealand.

Remarks—This is another of the several *Echinophoria* species which are extraordinarily alike, and may eventually have to be synonymized. This one is very close to Powell's *multinodosum* and Laws' *emilyae*. Dell's original description reads:

"Shell fairly large, suboval, inflated, non-umbilicate. Spire moderately high, more than half the height of aperture in adult specimens. Spire whorls obtusely angled, shoulder slightly concave, broad. Body whorl with concave shoulder, inflated below, base broadly convex contracting to strong twisted columella which bears a well marked fasciole. Sculpture on spire whorls consists of a row of well marked, strong, sharp nodules on shoulder. Penultimate whorl with an additional row emerging from lower suture. Body whorl with two additional lower rows. Nodules on body whorl fairly sharp and well marked. Suture strongly impressed, with a well-developed subsutural cord crossed by strong, oblique growth lines. In addition there is well marked spiral sculpture of raised, somewhat flexuous threads, fine on the shoulder, becoming obsolete over the nodules and very well developed on base, the whole crossed by close-spaced growth lines. Outer lip damaged in all available specimens. Inner lip with thin layer of callus. Columella damaged in all specimens but there is a single well developed fold near the base with a series of rapidly decreasing lesser folds above. Holotype; height 54 mm. (actual), 58 mm. (estimated); diameter, 39 mm."

Synonymy—

1952 *Euspinacassis oconnori* Dell, Dominion Mus. Records in Zoology, Wellington, vol. 1, no. 8, p. 75, figs. 4, 5 (Hurupi Creek, Palliser Bay, New Zealand. Holotype in Dom. Mus. no. M 5580).

Phalium grangei Marwick, 1926

(Pl. 94, figs. 5-6)

Range—Upper Miocene, North Taranaki, New Zealand.

Remarks—This species has been placed in various genera by New Zealand workers. Finlay (1926, p. 230) placed it in his *Euspinacassis* [i.e., subgenus *Echinophoria*], while Powell placed it in *Xenophalium*, and allied it to *fibratum*. The latter is the type of *Mauicassis*. Without recourse to well-preserved specimens, and

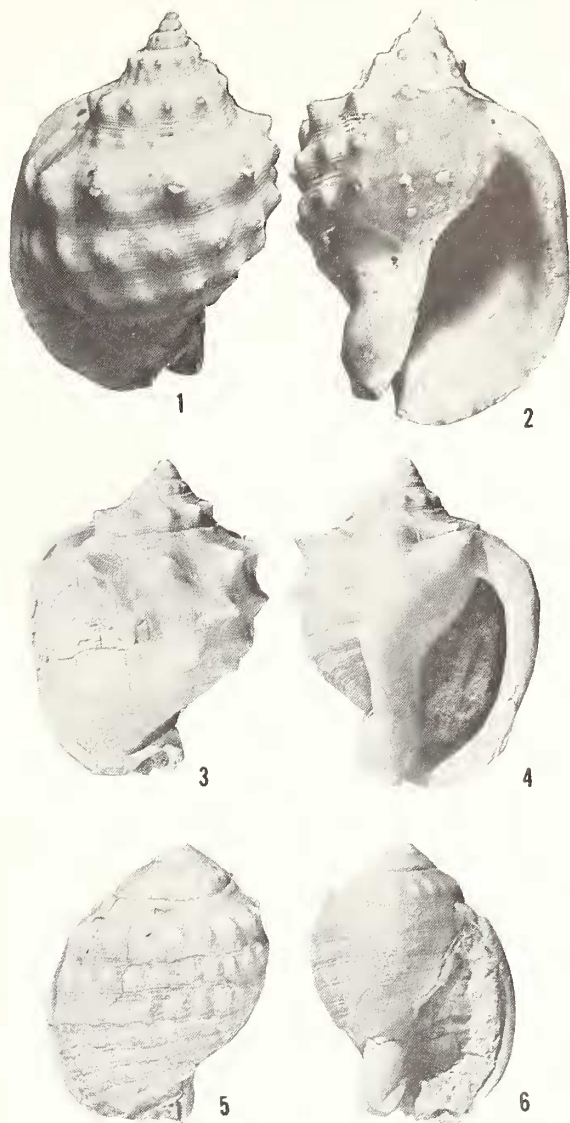


Plate 94. Figs. 1, 2, *Phalium (Echinophoria) emilyae* (Laws, 1932). Upper Oligocene, Ardgowan Shell-bed, Oamaru, New Zealand. Holotype, 55 mm. (photo courtesy of A. W. B. Powell). Figs. 3, 4, *Phalium (Echinophoria) hectori* Abbott, new name. Topotype of "*Cassis muricata* Hector", Kaipara Harbour cliffs, Auckland. Upper Eocene. 49 mm. Figs. 5, 6, *Phalium (Echinophoria) grangei* Marwick, 1926. Upper Miocene, North Taranaki, New Zealand, Holotype, 43 mm. (photo courtesy of the New Zealand Geological Survey).

relying only on the published description and figures, I am provisionally placing *grangei* in the subgenus *Echinophoria*. The original description reads:

"Shell of moderate size, suboval, inflated. Spire low, gradate to subconic, under one-third height of aperture. Spire-whorls obtusely angled, with a broad almost flat shoulder; body-whorl with slightly concave shoulder below which

it is inflated, base contracting quickly to short twisted neck bearing a conspicuous fasciole separated from constricted base by strong ridge. Sculpture: early whorls eroded, penultimate whorl with about 5 spiral threads on side and 6 on shoulder; interstices wide, each containing a secondary spiral; shoulder-angle with about 20 low blunt knobs; body-whorl with 8 cinguli, top one strongest, bottom five scarcely marked, top three with 12 to 16 rounded knobs, fourth sometimes with a few obscure ones, whole whorl with fine spiral threads. Suture strongly impressed, bordered on body by flattened cord crossed by strong oblique growth-lines. Aperture very deeply and obliquely notched below. Outer lip thickened, much reflexed. Columella somewhat damaged in all specimens but apparently with one strong grooved oblique fold at bottom of columella, above which are a number of wrinkles. Inner lip thin on the parietal wall, thickened below, fitting close to base and fasciole so that ridges of latter show through, and there is no umbilicus. Height, 43 mm.; diameter, 32 mm."

Synonymy—

- 1926 *Euspinacassis grangei* "Marwick", Finlay, Trans. and Proc. New Zealand Inst., vol. 56, p. 230, 231 (nude name).
 1926 *Phalium grangei* Marwick, *ibid.*, p. 319 (locality 1135, Tirangi Stream, North Taranaki, Upper Miocene, New Zealand).
 1928 *Xenophalium grangei* (Marwick), Powell, Trans. and Proc. New Zealand Inst., vol. 59, p. 636.
 1932 *Euspinacassis grangei* Marwick, Laws, *ibid.*, vol. 62, p. 190.



Plate 95. *Phalium* (*Echinophoria*) *oneroaensis* (Powell, 1938). Lower Miocene, Waiheke Island, New Zealand. Holotype, in the Powell collection, Auckland Mus., 44 mm. (photo courtesy of A. W. B. Powell).

Phalium oneroaensis (Powell, 1938)

(Pl. 95)

Range—Lower Miocene, Waiheke Island, New Zealand.

Remarks—Powell states that this species closely resembles and appears to be directly ancestral to *toreuma* (Powell), differing only in having a shorter spire with only the uppermost row of nodules showing on the spire whorls. The original description reads:

"Shell of medium size, massive, encircled with numerous rows of strong blunt tubercles; aperture heavily variced and calloused within; canal very short, deeply notched. Apex erect, dome-shaped, of three smooth regularly-coiled whorls, nucleus minute. Spire one-fourth height of aperture. Five spiral rows of nodules on the body-whorl, only the upper most showing on the spire-whorls. Between the lowest spiral row of nodules and the fasciole are three flat-topped subsidiary spiral cords without nodules. The nodules on the uppermost spiral number eleven on the body-whorl; they are subspinose; those on the lower spirals number fourteen, and are bluntly rounded. Whole surface overlaid with fine crowded spiral lirations. Aperture narrowly ovate. Outer lip with a very heavy varix, reflexed, and bearing weak denticles along the calloused inner edge. Parietal callus thick and spreading, with irregular plait-like ridges on the pillar, and bridging across the deep umbilical chink. Height, 44 mm.; diameter, 31 mm. (holotype)."

Synonymy—

- 1938 *Euspinacassis oneroaensis* Powell, Trans. and Proc. Royal Soc. New Zealand, vol. 68, pt. 3, p. 364, 374, pl. 39, figs. 10, 11. (small bay ½ mile N.W. of Oneroa Beach, Waiheke Island, New Zealand. "Upper Oligocene").

Phalium hectori new name Abbott

(Pl. 94, figs. 3, 4)

Range—Lower Miocene, Pakaurangi Point, New Zealand.

Remarks—This species has had an unfortunate bibliographic history. It appeared several times as a *nomen nudum* and was then proposed only with a name (*muricata* Hector) and figure citation. In 1915, Suter redescribed the species in detail, partially upon an excellent drawing of the lost holotype and partially upon a paratype which now in 1964 appears also to be lost. The name, *muricata*, furthermore is a primary homonym, and I propose the new name *Phalium* (*Echinophoria*) *hectori*. Suter's re-description reads:

"Shell moderately large, ovato-ventricose, with depressed spire, appressed suture, the spire-whorls with 1, the body-whorl with 3 to 4 spinous or tuberculous keels, the whole surface finely reticulated, outer lip somewhat reflexed, lirate towards the base, inner lip forming a broad callus, lirate below. Sculpture: Spire-whorls with a distinct keel at the lower third bearing sharply pointed tubercles, developing to bluntly pointed compressed spines on the last whorl, 8 to 9 on a volution; below the uppermost keel on the body-whorl there are 3 more equally spaced rows of tubercles, diminishing in size towards the base, the lowest row having only inconspicuous tubercles; the whole surface is ornamented by close, fine spiral threads, unequal in strength, usually stronger ones have from 1 to 3 much finer ones between them; on the base the stronger threads are broader and unequal in strength; these lirae are reticulated by sinuous growth-striae; the suture is margined below by a narrow band of irregular oblique riblets. Spire low, conoidal, its height about half that of the aperture. Protoconch small, papillate, consisting of 2 convex smooth whorls. Whorls 6, first slowly descending, but the last large and ventricose; spire-whorls slightly concave at the shoulder, flat below the keel; body-whorl convex, the shoulder lightly excavated, base very little contracted. Suture appressed, margined below. Aperture subvertical, ovate, obsoletely and broadly channelled above, produced below into a distinct, short, recurved canal. Outer lip broad, thick, slightly reflexed, strongly lirate at the lower third. Columella vertical, arcuate above, straight below, inflected towards the canal. Inner lip broadly reflexed over the body, its outer edge more or less free in the adult, with an entering low plait above, and irregular oblique folds on the lower part. The siphonal fasciole strong, sharply keeled. Height, 57 mm.; diameter, 40 mm. (from drawing of the lost holotype)."

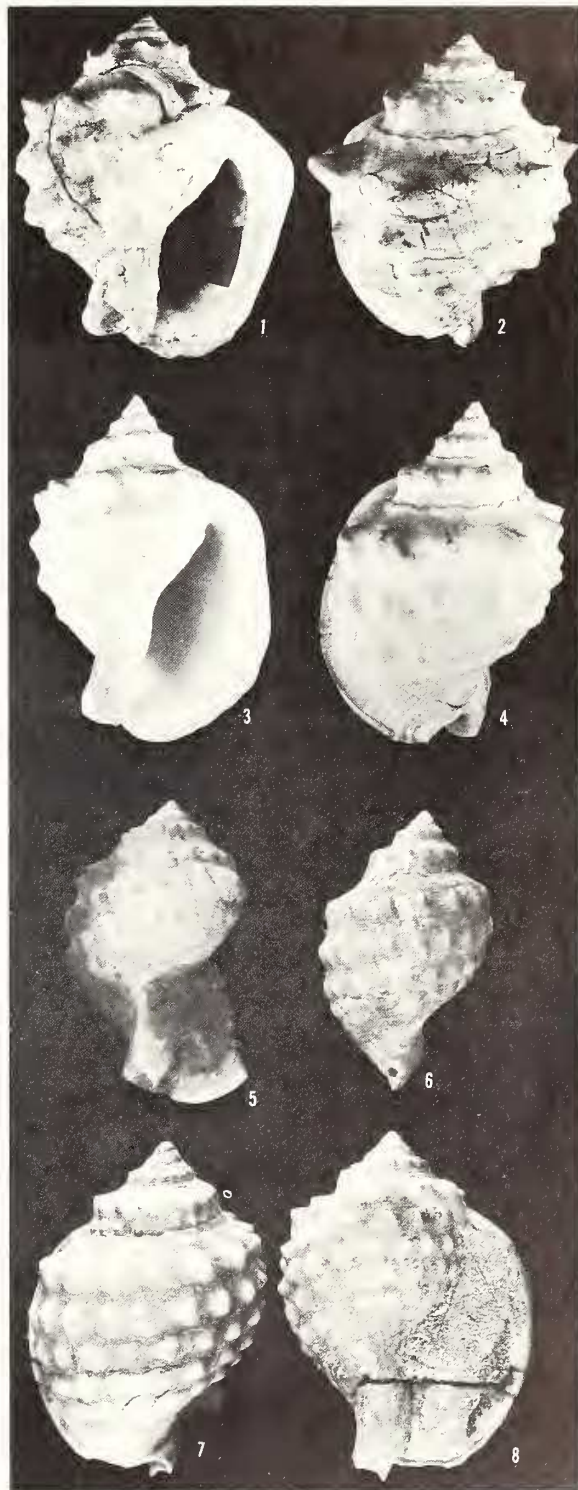


Plate 96. New Zealand fossil cassids. Figs. 1, 2, *Phalium (Echinophoria) pollens* Finlay, 1926, holotype, in Auckland Mus., Clifden, Southland; Altonian, Miocene, 69 mm. Figs. 3, 4, *Phalium emilyae* Laws, 1932, holotype, in Auckland Mus., Ardgowan shell bed, Oamaru, Awamoan, Upper Oligocene, 55 mm. Fig. 5, *Phalium (Echinophoria) multinodosum* Powell, 1928, holotype, in Auckland Mus., sea cliffs at Motutara, 30 miles west of Auckland in volcanic tuff of the Miocene, 50 mm. Fig. 6, paratype of *multinodosum*, 47 mm. Figs. 7, 8, *Phalium toreuma* (Powell, 1928), holotype, in Auckland Mus. (Powell Collection), Motutara, Miocene, 34 mm. (all courtesy of A. W. B. Powell).

Synonymy—

- 1877 *Cassid. muricata* Hector, Reports of Geological Explorations during 1874-6, Geol. Survey New Zealand, (ninth) Progress Report, p. v (nude name). Non *Cassid. muricata* Menke, 1828.
- 1881 *Cassid. muricata* Hector, MS, S.H.Cox, *ibid.*, for 1879-80, p. 33 (nude name).
- 1886 *Cassid. muricata* Park, *ibid.*, for 1885, p. 167 (nude name).
- 1886 *Cassid. muricata* Hector, "Detailed Catalogue and Guide to the Geological Exhibits", Indian and Colonial Exhibition in London, Wellington, p. 7, no. 59, and p. 51, fig. 9, no. 7 (Komiti, Kaipara, Auckland, Upper Eocene).
- 1915 *Galeodea muricata* (Hector), Suter, New Zealand Geol. Survey Paleont. Bull. no. 3, p. 12, pl. 1, fig. 6 (of the lost holotype). Miocene.
- 1931 *Phalium (Echinophoria) muricatum* Rutsch, Eclogae Geol. Helvetiae, vol. 24, p. 252.

***Phalium toreuma* (Powell, 1928)**

(Pl. 96, figs. 7, 8)

Range—Lower Miocene, Motutara, New Zealand.

Remarks—The shell has a close resemblance to that of the Recent deep-water Japanese *P. (Echinophoria) carnosum* Kuroda. Powell's original description reads:

"Shell rather small, strong, encircled by rows of strong rounded nodules. Outer lip rather thin, slightly recurved. Canal very short, broad, and deeply notched. Whorls $6\frac{1}{2}$, plus minute dome-shaped protoconch of $2\frac{1}{2}$ smooth whorls. Penultimate whorl with two rows of nodules, the lower one just showing above suture and the upper forming a prominent shoulder just above centre of whorl. Body-whorl with 5 distinct rows of close regularly-spaced rounded nodules and three plain indistinct spiral bands below. The four lower nodulous bands close together, the upper one separated from them by a greater distance. The whole shell covered with exceedingly fine spiral striae, not showing on nodules. The shoulder bears 13 nodules on body-whorl. Spire less than half height of aperture. Suture slightly undulating. Outer lip smooth within and slightly recurved. Inner lip spreading as a callus right to shoulder. Columellar-callus rather narrow almost closing false umbilicus. Pillar bordered by a single prominent ridge running right to base of columella. Fasciole smooth, flattened, bordered above by a narrow ridge. Height, 34 mm.; diameter, 24 mm."

The feminine noun "*toreuma*" means embossed work or bas-relief.

Synonymy—

- 1928 *Xenophalium toreuma* Powell, Trans. and Proc. New Zealand Inst., vol. 59, pt. 3, p. 636, figs. 33, 34. (Sea Cliffs at Motutara, West Coast, 30 mi. from Auckland in volcanic tuffs, associated with *Parvamussium zitteli* Hutton. Lower Miocene?).
- 1935 *Euspinacassis toreuma* (Powell, 1928), Powell, Records Auckland Inst. Mus., vol. 1, no. 6, p. 329 (about 1.3 mi. south from Muriwai Beach, Auckland).

***Phalium multinodosum* (Powell, 1928)**

(Pl. 96, figs. 5, 6)

Range—Lower Miocene, Sea Cliffs at Motutara, New Zealand.

Remarks—This is a typical, well-nodulated *Echinophoria* closely resembling *toreuma* (Powell). The latter, from the same locality, may possibly be a young and dwarfed variant of *multinodosum* in which the parietal shield has not become fully developed. Powell's original description reads:

"Shell large, strong, encircled with rows of strong rounded nodules. Outer lip very little thickened, slightly recurved. Canal very short, deeply notched. Whorls $6\frac{1}{2}$, plus minute, dome-shaped, protoconch of $2\frac{1}{2}$ smooth whorls. Spire-whorls angled at centre by a single spiral row of close regularly-spaced rounded nodules. Body-whorl with 4 rows of rounded nodules arranged axially in an oblique plane. First two rows widely spaced, last two close together. The upper row forming the shoulder has approximately 16 nodules on body-whorl as compared with 8 in *muricata*, and 11-13 in *pollens*. The whole shell is crowded with fine spiral lirae, alternating in strength. Spire a little less than half height of aperture. Suture undulating, just covering an otherwise second row of spire-nodules. Outer lip imperfect in both specimens. Inner lip spreading as a thin callus broadly over parietal wall almost to shoulder.

"Columella obliquely flexed, with heavy callus-plate almost closing false umbilical chink. Pillar with several indistinct irregular plaits. Fasciole flattened on top, longitudinally striated. Height [length] 50 mm.; minimum diam., 28 mm. (holotype).

Synonymy—

- 1928 *Euspinacassis multinodosa* Powell, Trans. and Proc. New Zealand Inst., vol. 59, p. 634, pl. 76, figs. 30, 31 (Sea Cliffs at Motutara, West Coast, 30 miles from Auckland in volcanic tuffs, associated with *Parvamussium zitteli* Hutton. Lower Miocene?).
- 1935, Powell, Records Auckland Inst. Mus., vol. 1, no. 6, p. 328-329.
- 1931 *Phalium (Echinophoria) multinodosum* Powell, Rutsch, Eclogae Geol. Helvetiae, vol. 24, p. 252.

Phalium emilyae (Laws, 1932)

(Pl. 94, figs. 1, 2; Pl. 96, figs. 3, 4)

Range—Lower Miocene, Ardgowan shell-bed, Oamaru, New Zealand.

Remarks—This species is extremely close to *P. hectori* Abbott and non-senile specimens of *P. pollens* Finlay. It is not unlike Recent deep-water *Echinophoria*. The original description reads:

"Shell fairly large, not of heavy build for its size, spire whorls with a row of tubercles at angle somewhat above middle; body-whorl with 4 rows of tubercles, those of the lowest row very weak and soon becoming obsolete towards outer lip; 11 in topmost row. Tubercles project vertically and show tendency to be laterally compressed. Whole surface covered by close spiral cords, the last six on the base (below last row of nodules) more regular and prominent and ornamented with spiral lines. Spire about half the height of the aperture. Spire whorls lightly concave both above and below the angle; a distinct concavity between tubercles in first two rows on body-whorl. Suture slightly undulating over hidden row of tubercles, appressed and margined below by a narrow swollen band. Outer lip thickened, reflexed, and carrying 8 or 9 denticles within, distinct in front, but becoming faint posteriorly. Inner lip spread as a wide and thick callus (not as thick as that of *muricata* Hector) almost completely covering nodules and reaching on to shoulder between tubercles of top row. Callus plate sunken over umbilicus, but rising anteriorly to surmount the low, rounded ridge on the fasciole. In *muricata* the callus plate is flat. Pillar with 3 or 4 small, irregular plaits below. Fasciole almost completely covered ventrally. A sharp keel behind separates it from the wide, deep groove leading to the umbilicus. In *E. muricata*, as the pillar is more erect and its base a good deal more twisted, the fasciole is relatively wider when seen laterally and the groove behind much narrower. Further, in the Pakaurangi Point species this groove widens posteriorly, whereas in the new species the channel becomes slightly narrower towards the umbilicus. Height, 55 mm.; diameter, 36 mm." [*muricata*=*hectori* Abbott].

Synonymy—

1932 *Euspinacassis emilyae* Laws, Trans. and Proc. New Zealand Inst., vol. 62, p. 189, pl. 28, figs. 14, 15 (Ardgowan shell-bed, Oamaru (Awamoan), New Zealand).

Phalium pollens (Finlay, 1926)

(Pl. 96, figs. 1, 2)

Range—Lower Miocene, Clifden, Southland, New Zealand.

Remarks—This large, sometimes heavy, species is the type of Finlay's genus *Euspinacassis*, which I consider to be a synonym of the subgenus *Echinophoria* Sacco. Some specimens, perhaps because of old age and their development in cool water, produce a thick, heavy outer lip and parietal shield. Younger specimens are very close to some Recent and some Italian Pliocene species of *Echinophoria*. The Lower Miocene *P. pollens* (Finlay), *P. hectori* (Abbott) and *emilyae* Laws are all extremely close to each other and may well be weak subspecies or forms of each other. The original description of *pollen* reads:

"Shell large, massive, encircled with rows of strong high tubercles; aperture heavily thickened, canal very short, deeply notched behind. Apex symmetrical, dome-shaped, of 3 smooth regularly-coiled whorls, nucleus minute. Four spiral rows of nodules on last whorl, only the uppermost showing on spire-whorls; 11-13 strong pointed upwardly-directed spines per whorl on top row, about 17 lower blunter nodules on second and third rows, and many weak very low nodules on lowest row; 6-8 low spiral cords on base; whole surface overlaid by very numerous close undulating spiral grooves, interstices slightly raised as weak threads. Spiral threads coarser and plainer and fenestrated by numerous thin axial threads on early spire-whorls. Spire rather high, about half height of aperture, outlines straight. Whorls medially sharply angled by nodular keel, slightly concave above and below, strongly concave between nodular rows on body-whorl. Suture strongly undulating, a little cut in. Aperture in young shells distinctly phalioid, outer lip being thickened and reflexed and bearing several denticles below, inner lip merely a thin glaze over parietal wall and pillar, but free across excavation above fasciole and forming there a small but pervious umbilicus; pillar irregularly plaited and ridged, with one stronger medial blunt ridge later forming outer margin of fasciole. Adult shell has sides of aperture enormously thickened, outer lip very strong and with thickly laminate reflexed edge; inner lip spreading as a massive parietal callus almost up to top nodular row, and as a thick free edge across umbilicus and pillar, form-

ing another umbilicus on farther side of fasciole; pillar with numerous anastomosing sharp plaits and ridges, fasciole ridge covered. Canal very short, at once bent to left and slightly backwards by a strong deep notch almost exactly as in *Phalium*. Adult shell has a second projecting varix emerging obliquely from parietal callus. Fasciole with an anterior bluntly angular ridge, bounded behind by a sharp keel, a deeply-hollowed rounded groove immediately behind it, leading into umbilicus.

"Height, 69 mm.; diameter, 55 mm. (type). Height, 39 mm.; diameter, 27 mm. (paratype). Height 27 mm.; diameter, 18.5 mm. (paratype)."

Synonymy—

- 1926 *Euspinacassis pollens* Finlay, Trans. and Proc. New Zealand Inst., vol. 56, p. 230, pl. 55, figs. 10-12 (Clifden, Southland, band 6A (Otataran?), New Zealand, Lower Miocene).
1931 *Phalium (Echinophoria) pollens* (Finlay), Rutsch, Eclogae Geol. Helvetiae, vol. 24, p. 252, fig. b.

Phalium trinodosum (Tate, 1889)

(Pl. 97)

Range—Oligocene of Victoria, Australia.

Remarks—I am tentatively assigning this species to the subgenus *Echinophoria* because of Tate's description and on the basis of the nature of the sculpturing on the body whorl which resembles other species in this group. The original description reads:

"Shell globosely ovate, spire short, acuminate, ending in a small conical pullus of three smooth convex whorls.

"Whorls four, excluding pullus [nucleus], con-

vex, with depressed spiral ridges and narrower sulci.

"Last whorl ventricose, contracted at the base, sculptured with flatly rounded spiral ridges, and ornamented with three rows of tubercles, one on the rounded shoulder of the whorl, the third at about half way to the front, the second about midway between. The tubercles on the posterior row are the largest, smaller in size on the medial row, and somewhat inconspicuous on the anterior row.

"Aperture lunate; outer lip very much thickened and slightly reflexed, ascending to the middle of penultimate whorl; margin smooth, except a few obscure denticles at the front; columella somewhat patulous, smooth, dentately ridged on the margin. Length, 30; breadth, 21; length of aperture, 25 mm."

Synonymy—

- 1889 *Semicassis trinodosa* Tate, Trans. and Proc. Royal Soc. South Australia, vol. 11, p. 167, pl. 7, fig. 12 (Barnsdale, Gippsland, Victoria).



Plate 97. *Phalium (Echinophoria) trinodosum* (Tate, 1889). Type of *Semicassis trinodosa* Tate, 1889, from the Oligocene of Gippsland, Victoria, Australia. Length: 30 mm.

Subgenus Maucassis Fleming, 1943Type: *Phalium fibratum* Marshall and Murdoch, 1920

Members of this subgenus are characterized by *Tonna*-like, wide, heavy, straplike spirals, which may be nodose or slightly spinose and are continuous to the edge of the outer lip. The siphonal canal is usually bordered posteriorly by a wide deep groove. Thirteen Tertiary species may be assigned to this group, although some of them possess at least one character or another which makes their inclusion problematical. The Recent *Phalium whitworthi* Abbott from Western Australia has strap-like spirals and a deep groove behind the siphonal canal, but for reasons mentioned under its remarks I consider it a close relative of *Phalium* (*Xenophalium*) *thomsoni* (Iredale) of eastern Australia.

Maucassis, with *fibratum* as its type, was proposed by Fleming in 1943. Other Miocene and Pliocene species occur in Japan and north-western United States. An extreme form, *petrosum* Conrad, was chosen as the type of *Liracassis* by E. J. Moore in 1963. It should be pointed out that the difference between a sculpture of "wide, strap-like spirals" and "a smoothish surface with deep, incised spiral lines" is only a matter of degree of the same morphological origin. These characters may be constant for some species, but should not necessarily be used as evidence of phylogenetic relationships. The presence or absence of spiral straps occur within forms of the same species, i.e. *Phalium* (*Semicassis*) *granulatum-cicatricosum* of the Recent Caribbean.

There are no living examples of *Maucassis*, unless one wishes to conjecture, and perhaps not unjustifiably, that *Phalium wyvillei* (Watson) and other deep-water forms are direct descendants.

Synonymy—

- 1943 *Maucassis* Fleming, Trans. and Proc. Royal Soc. New Zealand, vol. 73, pt. 3, p. 197 (type by original designation: *Phalium fibratum* Marshall and Murdoch, 1920, Lower Pliocene, New Zealand).
 1963 *Liracassis* E. J. Moore, U.S. Geol. Survey Prof. Paper, 419, p. 30 (type by original designation: *Dolium petrosum* Conrad, 1849, Miocene, N. W. United States).

***Phalium fibratum* Marshall and Murdoch, 1920**

Range—Lower Pliocene of New Zealand, Waitotaran beds.

Remarks—This 3-inch long (75 mm.), ovate-globose, cassid has about 23 prominent strap-like spirals on the last whorl with a groove, half as wide, between them. The spiral on the upper part of the shoulder has prominent, but small, nodules. I quote the original description in full: "Shell large, ovate-globose, with prominent spiral sculpture. Whorls about seven, lightly angular; apex minute; spire short, less than one-quarter the length of the aperture; the last very large; on the angle a rather prominent row of nodules, on the spire above the angle four or five spiral cords, and below the angle two or three, on the last about twenty-three flat spirals more than twice the width of the grooves, the latter becoming deeper on approaching the anterior end, in places there is a small groove on the rib, and here and there a small threadlet in the groove; the axials consist of strong irregular growth-striae which have a fibrous subgranular appearance. Sutures lightly impressed, the marginal rib below rather pronounced. Aperture slightly oblique and narrow above, outer lip uniformly curved, thickened and reflexed; columella short, excavate and twisted, several small denticles above and two or three oblique plaits at the anterior end; body-whorl and columella with a wide, spreading callus produced anteriorly as a broad flat plait limited to the width of the columella. Length; 75 mm.; width: 60 mm."

Synonymy—

- 1920 *Phalium fibratum* Marshall and Murdoch, Trans. and Proc. New Zealand Inst., vol. 52 (new issue), p. 131, pl. 8, figs. 16, 17 (Waipipi).

Types—The type locality is Waipipi, Waitotaran Beds, Lower Pliocene beds of New Zealand. The holotype was to have been presented to the Wanganui Museum.

***Phalium kaawaense* (Bartrum and Powell, 1928)**

(Pl. 98)

Range—Lower Pliocene, Kaawa Creek, west coast, New Zealand.

Remarks—I have not seen this species which bears two rows of low, somewhat evenly-sized nodules on the shoulder. There is a third inconspicuous row, below which are 13 strong spiral ridges. the original description reads:



Plate 98. *Phalium (Mauicassis) kaawaense* (Powell and Bartrum, 1928), holotype, in Auckland Mus. 67 mm. (courtesy of A. W. B. Powell).

"Large inflated shell, with low conical spire, closely resembling *X. grangei* (Marwick). Earlier spiral-whorls almost flat in outline, later ones slightly convex; body-whorl slightly concave above the broadly-rounded nodular shoulder-angle, but below this, swollen above and rapidly contracting towards base. Suture bordered below by a low spiral fold with three strong spiral threads beneath on shoulder. Fasciole and outer lip broken away. Inner lip has expanded callus extending to the nodular shoulder-angle of body-whorl, thin on parietal wall but thicker below and practically closing false umbilicus. Columella callus smooth and fairly thick near base. Columella has 2 oblique folds near base, not 1 as in *grangei*. Ornamentation differs from that of *grangei* by having two strong nodular cinguli and an inconspicuous third on body-whorl, in place of three and an inconspicuous fourth, whilst intermediate sculpture is very much stronger. Spire shows only one nodular spiral as in *grangei*. Between each pair of nodular cinguli, there are two smaller similar bands separated by shallow narrow interspaces. Below the lowest, or third, nodular cingulus there are 13 similar rounded spiral ribs separated by narrow grooves. Protoconch worn. Dimensions of holotype: Height, 67 mm.; breadth, 48 mm."

Synonymy –

1928 *Xenophalium kaawaensis* Bartrum and Powell, Trans. and Proc. New Zealand Inst., vol. 59, p. 145, figs. 53, 54 (Kaawa Creek, south of Waikato River, Tertiary of New Zealand); 1928, Powell, *ibid.*, vol. 59, p. 637, fig. 32.

Phalium lilliei (Fleming, 1943)

(Pl. 99, fig. 2)

Range – Lower Pliocene, Waitotaran Stage, of New Zealand.

Remarks – This species differs from *fibratum* in having a higher spire and finer, less nodulous, spiral sculpture which does not have the beaded effect of *fibratum*. Fleming's original description reads:

"Whorls encircled with a single row of strong rounded nodules (15-16 per whorl) and with a concave shoulder below the suture. On the shoulder, above the nodules, are five low, flat spiral threads, slightly undulating and crossed by growth lines which develop secondary threads in their shallow interspaces on later whorls; 3-4 wider and lower spiral threads traverse the nodules. Below the nodulous keel there are 1-2 broad, flat-topped spirals on earliest spire whorls, but as the suture descends steeply, five are exposed on the penultimate. On the body whorl below the keel there are 22 such spirals, frequently divided secondarily by 1-2 fine grooves in their flat summits; the interspaces, which are about half as wide as the threads, also develop secondary threads, especially on the base and below the periphery. Aperture elongate, not expanded. Outer lip thick, recurved and smooth within. Columellar callus plate thick and smooth. False umbilicus small. Four plaits on columella. Dimensions: Height, 61; diameter, 45 mm."

Synonymy –

1943 *Xenophalium (Mauicassis) lilliei* Fleming, Trans. Royal Soc. New Zealand, vol. 73, pt. 3, p. 198, pl. 29, fig. 18 (locality 2675, Tahoraite (S.W.), S.D. Waitotaran).

Phalium marwicki (Fleming, 1943)

(Pl. 99, fig. 1)

Range – Lower Pliocene, Waitotaran Stage, of New Zealand.

Remarks – This fossil cassid lacks the nodulation of other species of New Zealand *Mauicassis*, but is well marked by strong, flat-topped, spiral ridges. The original description reads:

"Sculpture: Slight indications of weak tubercles at the suture in early spire whorls, but last three whorls show only spiral sculpture of smooth, flat threads of irregular width with deep, groove-like interspaces. On the penultimate there are 23 threads, varying in width, and with inter-

spaces also varying in width and depth. On the body whorl spirals tend to be alternately wide and narrow on the base and the grooves separating them are there deepest. Elsewhere secondary threads divide the surface somewhat irregularly. Outer lip thin, unthickened, but recurved, with about 16 low denticles, strongest anteriorly, becoming obsolete behind. Columellar callus-plate thin, delimiting large false umbilicus. Dimensions: Height, 68.5; diameter, 50 mm."

Synonymy—

1943 *Xenophalium* (*Mauicassis*) *marwicki* Fleming, Trans. Royal Soc. New Zealand, vol. 73, pt. 3, p. 199, pl. 29, fig. 19 (locality G.S. 2499. Tahoraite (S.W.), S.D., Upper Waitotaran).

Phalium onishpetensis Otuka, 1937

(Pl. 99, fig. 8)

Range—Miocene of Hokkaido Id., Japan.

Remarks—This species is provisionally placed in the subgenus *Mauicassis*. E. J. Moore (1963, p. 31), provisionally placed it in her genus, *Liracassis*. The only known specimen is poorly preserved and is probably immature. Otuka's original description follows:

"Shell moderate in size [49.2 mm. in height;

35.7 mm. in width], globose; whorls rounded, slightly shouldered; spire moderately high; whorls sculptured with many nodulose spiral ribs and fine spiral cords. Body whorl sculptured with 13 spiral ribs, upper spiral ribs being nodulose. Nodules of the rib on the shoulder margin are most prominent (about 5 within a length of 2 cm in type specimen). On the shoulder area 3 nodulose ribs exist, nodules of which number about 5-6 within a length of 1 cm. Between these nodulose ribs on the shoulder, there are 1 or 2 fine spiral cords which are narrower than the interspaces. On the surface below the shoulder are more or less smooth spiral ribs which interspaces are sculptured with about 4 fine unequal spiral cords. Suture collared. Sub-sutural area grooved, columellar *Doliocassis* [*Mauicassis*] type."

Synonymy—

1937 *Phalium* (*Doliocassis*) *onishpetensis* Otuka, Japanese Jour. Geol. and Geography, vol. 14, art. 13, p. 170, pl. 16, fig. 4 (upper course of the Toyomakubetu River, Soya-mura, Hokkaido Id., Japan).

1963 ?*Liracassis onishpetensis* Otuka, E. J. Moore, U. S. Geol. Survey Prof. Paper, 419, p. 31 (Onishpets formation, Miocene, Japan).



Plate 99. Members of the subgenus *Mauicassis*. Fig. 1, *Phalium* (*Mauicassis*) *marwicki* (Fleming, 1943). Tertiary, Upper Waitotaran; Dannevirke, New Zealand. Holotype. 68.5 mm. Fig. 2, *P. (M.) lilliei* (Fleming, 1943). Tertiary, Upper Waitotaran; Dannevirke, New Zealand. Holotype. 61 mm. (both from Fleming, 1943). Figs. 3, 4, *P. (M.) yokoyamai*

Nomura and Hatai, 1933 (holotype of *Galeodea japonica* Yokoyama, 1923). 60 mm. Figs. 5-7, *P. (M.) yokoyamai* Nomura and Hatai, 1933. Miocene, Susahara Formation, Toyama-Ken, Japan, 47 mm. Fig. 8, *P. (M.) onishpetensis* Otuka, 1937. Tertiary of Hokkaido, Japan. Holotype. 49.2 mm.

***Phalium yokoyamai* Nomura and Hatai, 1933**

(Pl. 99, figs. 3, 4)

Range—Lower Pliocene, Japan.

Remarks—I have not seen this or the following species which seem very similar to each other. Nomura and Hatai have given a rather detailed account of both (1933, p. 50-53). Yokoyama's original description is as follows:

"Shell solid, oval, ventricose. Whorls about seven with the body-whorl more than three times as long as the spire; convex, spirally as well as longitudinally sculptured. Spiral sculpture; consists of more or less flat cords, five on the penultimate and twelve on the ultimate whorl, the uppermost on the former is close to the upper suture, while the lowest is very near the lower, the interspaces between the cords being in the upper part broader than the cords themselves, but gradually decreasing in breadth; on the body whorl the two uppermost interspaces are not only broader than the others, but also several times broader than the cords and furnished with a few spiral striae on the surface; the remaining interspaces are subequal in breadth, but always a little broader than the cords. Longitudinal sculpture; consists of distant threads, eighteen on the penultimate and twenty on the ultimate whorl, which on crossing the cords become tubercular with tubercles most distinct on the three upper whorls. On the whorls above the penultimate, the sculptures, spiral as well as longitudinal, are not very distinct. Outer lip strongly varicose without and coarsely dentate within, the teeth corresponding in position to the cords outside. Aperture acute behind, fractured in front. Height 60 mm. Diameter 35 mm."

Synonymy—

- 1923 *Galeodea (Sconsia) japonica* Yokoyama, Japanese Jour. Geol. and Geography, vol. 2, no. 1, p. 3, pl. 1, figs. 4. (Kagami Neogene of Izuma, Japan); 1923, Yokoyama, Jour. College Sci. Imperial Univ. of Tokyo, vol. 65, art. 2, p. 11 (Lower Pliocene of Izuma); 1923, Yokoyama, *ibid.*, vol. 65, art. 5, p. 11, pl. 1, fig. 10 (Izura; Yunami. Pliocene of Izuma); 1926, Yokoyama, Jour. Faculty of Sci. Imperial Univ. Tokyo, section 2, vol. 1, pt. 7, p. 240 and pt. 9, p. 342 (Satsuka Beds: Dainichi).
- 1927 *Tonna japonica* (Yokoyama), Makiyama, Memoirs College Sci. Kyoto Imperial Univ., series B, vol. 3, no. 1, p. 73 (Tertiary of Nara). Not *Tonna japonica* (Dunker, 1867).
- 1933 *Phalium yokoyamai* Nomura and Hatai, Japanese Jour. Geol. and Geography, vol. 11, p. 50, pl. 8, figs. 1, 1a, 3. New name for *Phalium japonicum* Yokoyama, 1923, non *Phalium japonicum* (Reeve, 1848)=*bi-sulcatum* Schubert and Wagner, 1829.

1937 *Phalium (Doliocassis) yokoyamai* Nomura and Hatai, Otuka, *ibid.*, vol. 14, p. 170.

1949 *Shichiheia yokoyamai* Nomura and Hatai, Hatai and Nisiyama, Jour. of Paleontology, vol. 23, no. 1, pp. 93, 94.

1963 *Liracassis yokoyamai* Nomura and Hatai, E. J. Moore, U. S. Geol. Survey Prof. Paper, no. 419, p. 30 (Fujina and Sugota formations, Miocene, Japan).

Nomenclature—As long as this species is assigned to the genus *Phalium*, the name *yokoyamai* Nomura and Hatai may be used, but should *Semicassis*, *Liracassis* or *Manicassis* be used as a full genus, the name *japonica* Yokoyama, 1923, will have to be re-instated, since *Cassis japonica* Reeve, 1848, does not preoccupy *Galeodea japonica* Yokoyama while they are currently in different genera.

Records—(all from Nomura and Hatai, 1933, p. 52). Lower Pliocene of Japan: Higashi-Kimachi, Kimachi-mura, Yatsukagun, Prov. of Izumo; Otsu, Hirakata-mura, Taga-gun, Prov. of Hitachi, Honshu; the Tokiwa Series; Tennoyama, near Kakegawa, Prov. of Totomi, lower Kakegawa Series; Tsurushi-hama near Sukegawa, Prov. of Hitachi, Shirado Beds; oil fields of Embets, Beds A and C, Teship-gun, Prov. of Teshio, Hokkaido.

***Phalium yabei* Nomura and Hatai, 1933**

Range—Pliocene and Miocene of Honshu, Id., Japan.

Remarks—This species and *yokoyamai* are evidently very close to *Phalium iani* Schenck, 1926, from the Miocene of Washington State. The original description follows:

"Shell of moderate size, oval, with about seven rounded whorls separated by a distinct, appressed, but not channeled suture; body whorl nearly three times as long as the spire; apex rather acute, the surface generally is spirally as well as longitudinally sculptured; spiral sculpture consisting of strong, somewhat flattened cords regularly spaced and separated by nearly equal, channeled interspaces, twelve on the body whorl, and five on the penultimate whorl, generally provided with one or two interstitial threads between the cords, except the few basal ones; the striae on the upper part of the body whorls being stronger than the lower ones; axial sculpture consists of several threads extending from suture to suture and becoming obsolete on the base of the body whorl; on crossing the axial and spiral cords they become distinct tubercles or nodules; tubercles becoming obsolete towards the base. Outer lip thickened, reflected and coarsely dentate within; inner lip with thin callosity, smooth above, plicate below. Canal short, rather wide, slightly recurved. Aperture rather

small, acute behind and obtuse in front; pillar (?) short. One of the specimens measures 47 mm. in height and 35 mm. in diameter."

Synonymy—

- 1933 *Phalium yabei* Nomura and Hatai, Japanese Jour. Geol. and Geography, vol. 11, p. 52, pl. 8, figs. 2, 4, 5, 6, 8, 8a (type locality here selected: Yawata, Tomino-mura, Date-gun, Prov. of Iwaki; Yanagawa Beds, Beds of Tsujita; Reg. No. 38601).
- 1940 *Phalium (Doliocassis) yabei* Nomura and Hatai, Nomura, Tohoku Imperial Univ. Sci. Reports series 2, Geology, vol. 21, no. 1, p. 39 (Kita-Akai, Moniwa Shell Beds, Sendai, Japan; Miocene).
- 1949 *Shichiheia yabei* Nomura and Hatai, Hatai and Nisiyama, Jour. of Paleontology, vol. 23, no. 1, p. 93.
- 1963 *Liracassis yabei* Nomura and Hatai, E. J. Moore, U.S. Geol. Survey Prof. Paper, 419, p. 30 (Yanagawa formation, Miocene and Sueno-matsuyama formation, Pliocene, Japan).

Records—See under synonymy.

Phalium petrosum (Conrad, 1849)

Range—Miocene, Astoria formation of north-west United States.

Remarks—*Phalium petrosum* (Conrad) is characterized by having strong subrounded straplike spiral cords on the body whorl beneath the shoulder. The spiral cord at the shoulder is produced into about 17 nodes which continue as ridges to the suture. The cords on the spire are smaller than those on the body whorl but are also produced into nodes at the shoulder, with a faint trace of a ridge continuing from the nodes to the suture. At least 10 cords are present below the shoulder of the body whorl and 3 below the shoulder of the spire. There are fine spiral threads between the cords on the body whorl; the median of these threads may be more strongly developed than the others. (from E. J. Moore, 1963, p. 31).

The species is variable, and a rare *forma* was named *biliratum* (Conrad, 1865) in which the nodes on the shoulder of the body whorl are more produced and spinelike, in which there are subdued nodes on the spiral cord at the base of the angulation below the shoulder, a more concave shoulder without the strong ridgelike continuations of the nodes to the suture, and finer spiral cords on the shoulder.

A full account of this species was given by E. J. Moore (1963, pp. 30, 31). She points out that Reagan (1909, pl. 3, fig. 32), Dall (1909, pl. 14, fig. 6) and Tegland (1931, pl. 65, figs. 6, 7) figured but mis-identified this species as *apta* Tegland, 1931.

Synonymy—(also see E. J. Moore, 1963, p. 31).

- 1849 *Dolium petrosum* Conrad, U. S. Explor. Exped., Geology, vol. 10, appendix p. 727, atlas pl. 19, figs. 3-5 (Astoria, Oregon); 1963, E. J. Moore, U. S. Geol. Survey Prof. Paper, 419, p. 31, pls. 2, 4 and 10 (lecto-type, USNM no. 561550, selected and figured).
- 1865 *Doliopsis biliratum* Conrad, Amer. Jour. Conchology, Philadelphia, vol. 1, p. 150 (refers to his 1849, pl. 19, figs. 4a, 4b).
- 1963 *Liracassis petrosa* (Conrad), E. J. Moore, *loc. cit.*, pp. 30, 31, pls. 2, 4 and 10.

Phalium fax (Tegland, 1931)

Range—Oligocene, Lincoln formation, north-west United States.

Remarks—While placed in *Liracassis* [i.e. *Maicassis*] by Moore (1962), this species could also be placed in the subgenus *Echinophoria*, as was done by Durham (1942). The shell is well-figured by Tegland and by Durham, and I am not repeating Tegland's lengthy, original description. Durham distinguishes it from other Oligocene species in stating the "spiral ribs not cord-like except anteriorly on body whorl, body whorl strongly carinated by three rows of nodes, shoulder above first row of nodes strongly concave, suture appressed, spirals above shoulder of even size, 7 to 8 in number."

Weaver states that this species is common in the middle Oligocene of Oregon and Washington.

Synonymy—

- 1931 *Galeodea fax* Tegland, Univ. Calif. Publ. Bull. Dept. Geol. Sci., vol. 19, p. 412, pl. 59, figs. 4, 5. (Porter shale, Lincoln horizon, Oligocene, Chehalis Co., Washington); 1942, Weaver, Univ. Wash. Publ. Geol., vol. 5, p. 406, pl. 79, figs. 9-11.
- 1942 *Echinophoria fax* (Tegland), Durham, Jour. of Paleontology, vol. 16, p. 185, pl. 30, fig. 4. (holotype re-figured).
- 1963 *Liracassis fax* (Tegland), E. J. Moore, U.S. Geol. Survey Prof. Paper, 419, p. 30.

Phalium rex (Tegland, 1931)

(Pl. 100)

Range—Upper Oligocene, Blakely formation, Puget Sound Basin and north side of Olympic Peninsula, Washington State.

Remarks—This species could be placed either in the subgenus *Maicassis* or *Echinophoria*. It is characterized by its large size, strong tabulation, prominent, relatively broad, flat-topped spiral ribs without secondary ribs in the interspaces, and strong compressed nodes.

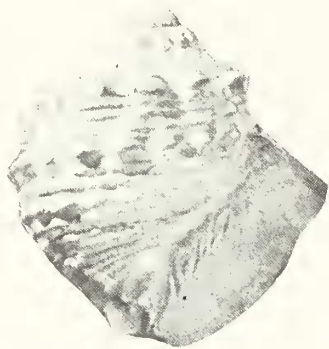


Plate 100. *Phalium (Mauicassis) rex* (Tegland, 1931). Holotype of *Galeodea rex* Tegland. Upper Oligocene, Seattle, Washington. Length: 70 mm. (from Durham, 1944, pl. 18, fig. 10).

Synonymy—

- 1913 *Eudolium petrosus* (Conrad), Arnold and Hannibal, Proc. Amer. Philos. Soc., vol. 52, p. 583; 1916, Weaver, Univ. Wash. Publ. Geol., vol. 1, pp. 6, 30; 1917, Dickerson, Proc. Calif. Acad. Sci., series 4, vol. 7, p. 163; 1918, Van Winkle, Univ. Wash. Publ. Geol., vol. 1, no. 2, p. 76.
- 1931 *Galeodea rex* Tegland, Univ. Calif. Publ. Bull. Dept. Geol. Sci., vol. 19, pp. 413-416, pl. 60, fig. 12, pl. 61, figs. 1-4, pl. 62, figs. 1-6 (Restoration Point, Kitsap Co., Seattle, Wash., Upper Oligocene); 1942, Weaver, Univ. Wash. Publ. Geol., vol. 5, p. 407, pl. 80, figs. 2, 4, 6.
- 1942 *Echinophoria rex* (Tegland), Durham, Jour. of Paleontology, vol. 16, p. 185, pl. 30, figs. 1-3. (holotype re-figured).
- 1963 *Liracassis rex* (Tegland), E. J. Moore, U. S. Geol. Surv. Prof. Paper, 419, p. 30 (late Oligocene or early Miocene, Washington and Oregon).

Phalium apta (Tegland, 1931)

(Pl. 101)

Range—Upper Oligocene, Blakeley formation, Clallam Co., Washington State.

Remarks—When one examines the specimens and figures of *P. apta* and *rex*, both from the Blakeley formation, one wonders how much variation should be allowed for these “paleontologists’ species.” Weaver’s 1942 figures of *apta* (pl. 80, fig. 5) and *rex* (pl. 30, fig. 6) leave little room for valid differentiation. It must be that variation within a species did not enter the evolutionary scheme until Recent times, otherwise the paleontologists could not justify their manufacture of numerous genera and species. It is convenient, and practical, to have index species, but this concept can continue only while relatively few specimens and locality records are available. Further field work will doubtlessly produce the intergrades or perhaps even more “species” and “genera”. The differences carefully illustrated and described are actually those existing between specimens, not species.

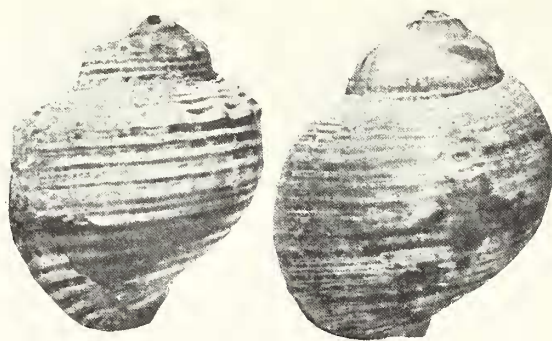


Plate 101. *Phalium (Mauicassis) apta* (Tegland, 1931). Holotype (left) and paratype (right) of *Galeodea apta* Tegland. Upper Oligocene, Clallam Co., Washington. Length: 55 mm. (from Durham, 1944, pl. 18, figs. 13, 15).

As Weaver states, “this important upper Oligocene species differs from *G. rex* Tegland in being relatively smaller [but his figure 5 of *apta* is larger than his figure 6 of *rex*, both $\times 1$] and less tabulate [not according to figs. 3 and 5 of *apta* as compared with figs. 4 and 6 of *rex*!] with somewhat rounded shoulders [fig. 3 of *apta* has less rounded shoulders than *rex*, fig. 6]. Other comparisons by Weaver concerning narrowness of ribs, size of interspaces and number and size of nodes are equally uninformative and unjustified.

Synonymy—

- 1909 *Eudolium petrosus* Conrad, Dall, U. S. Geol. Surv. Prof. Paper, 59, p. 71, pl. 14, fig. 6.
- 1931 *Galeodea apta* Tegland, Univ. Calif. Publ. Bull. Dept. Geol. Sci., vol. 19, pp. 415-417, pl. 63, fig. 1-10 (In sea cliff one-half mile west of Twin Rivers, Clallam Co., Washington); Weaver, 1942, Univ. Wash. Publ. Geol., vol. 5, p. 408, pl. 79, figs. 12, 13, pl. 80, figs. 1, 3, 5.
- 1942 *Trachydolium dalli* Howe, Weaver, loc. cit., p. 408 (in synonymy of *apta*).
- 1942 *Echinophoria apta* (Tegland), Durham, Jour. of Paleontology, vol. 16, pp. 185, 190, pl. 30, figs. 6-8.
- 1963 *Liracassis apta* (Tegland), E. J. Moore, U. S. Geol. Surv. Prof. Paper, 419, p. 30.

Phalium tegalensis (K. Martin, 1899)

Range—Pliocene of Pangka, Java, Indonesia.

Remarks—The sole immature specimen is so poorly preserved that I only provisionally assign *tegalensis* to the subgenus *Mauicassis*. Martin likened it to the Recent *P. (Semicassis) granulatum*, but the noded cords are too distantly spaced, and the contours of the whorls too globose to justify this relationship.

Synonymy—

- 1899 *Cassis (Semicassis) tegalensis* K. Martin, Samml. Geol. Reichsmus. Leiden, Neue Folge, vol. 1, pt. 1, p. 156, pl. 24, figs. 363, 363a, 363b (Pangka, District Gantungan, Tegal, Java; Pliocene).

Subgenus *Galeodosconsia* Sacco, 1890

Type: *Phalium striatulum* Bell. and Mich., 1841

During the Eocene and Oligocene of Europe and North America there existed a number of cassids which combined the characters of typical *Sconsia*, *Phalium*, and *Galeodea*. The subgenus *Galeodosconsia* was erected by Sacco for this "intergrading" group. The nucleus of the shell is that of a *Phalium*. The siphonal fasciole is poorly produced, and in most species there is a very weak channel posterior to it. In most species the outer lip is curled and thickened inwardly, rather than outwardly. This causes former varices to protrude on the inside of the shell.

Synonymy—

- 1890 *Galeodea* (subgenus *Galeodosconsia*) Sacco, I Molluschi dei Terreni Terziarii del Piemonte e della Liguria, pt. 7, p. 69. Type by original designation: *Cassidaria striatula* Bon. = *Cassis striatula* Bellardi and Michelotti, 1841; also by Cossmann's subsequent 1903, p. 133 designation.
- 1909 *Phalium* (*Doliocassis*) Dall, U. S. Geol. Survey, Professional Paper no. 59, p. 62. Type by original designation: *Buccinum sowerbyi* Lea = *Cassis nupera* Conrad, 1833. Eocene.
- 1928 *Sconsia* (*Galeodosconsia* Sacco), Woodring, Carnegie Institution of Washington, Publ. no. 385, p. 308.

We are placing the following species in *Phalium*'s subgenus *Galeodosconsia* with some reservations. Wrigley (1934) and others have at times listed these species as "*Cassis*".

European

Cassis striatula "Bonelli" Bellardi and Michelotti, 1841, Memorie Reale Accademia Scienze Torino, ser. 2, vol. 3, p. 143, pl. 4, fig. 7, 8 (Torino; Miocene of Italy); Sacco, 1890, I Molluschi Terreni Terziarii Piemonte Liguria, pt. 6, p. 69, 70 with variety *ottnangiensis* Sacco and its subvariety *elegans* Sacco and variety *subottnangiensis* Sacco, pl. 2, figs. 27, a, b (Elveziano, Colli torinesi); Hoernes and Auinger, 1879, Abhandlungen der K. K. Geologischen Reichsanstalt, Vienna, vol. 12, pt. 1, p. 162, pl. 17, fig. 14 (Ottang, Austria; Miocene).

Cassis calantica Deshayes, 1835, Description Coquilles Fossiles des Environs de Paris, vol. 2, p. 640, pl. 85, figs. 17-19 (Valmondois, Paris

Basin); 1911 Cossmann and Pissarro, Iconographie Coquilles Eocene Paris, vol. 2, pl. 33, fig. 165-4, pl. 34, fig. 165-4 as *calantica* [sic]; Wrigley, 1934, Proc. Malacol. Soc. London, vol. 21, no. 2, p. 118, fig. 20 (Auversian, Upper Bracklesham Beds of Huntingbridge, England; Lower Oligocene of Belgium and north Germany). *C. quenstedti* is a synonym.

Cassis quenstedti Beyrich, 1854, Zeit. deutsch Geol. ges., vol. 6, p. 470, pl. 10, fig. 2a, b (is *calantica* Deshayes, fide Wrigley, 1934, p. 118).

Cassis striata J. Sowerby, 1812, Mineral Conchology of Great Britain, vol. 1, p. 24, pl. 6 (lower 4 figs.). Not *Cassis striatus* de Serres, 1829, nor *Cassidaria striata* Lamarck, 1816. See Wrigley, 1934, p. 116, who says synonyms are *Cassidaria ambigua* J. de C. Sowerby, 1850, and *spinosa* Newton, 1891 (nude name and non Deshayes, 1844).

Cassidaria ambigua J. de C. Sowerby in Dixon, 1850, Geology. . . of Sussex, ed. 1, pl. 15, fig. 9. Non Solander, 1766, which is a *Sconsia*. Is a synonym of *Galeodosconsia striata* J. Sowerby, 1812.

Cassis germari Philippi, 1847, Palaeontographica, vol. 1, no. 2, Mar. 1847, p. 75, pl. 10, fig. 13 (1845 name is nude). Is synonym of *striata* J. Sowerby, 1812, fide Glibert, 1963, p. 109. Lower Oligocene.

Cassis germari var. *lima* von Koenen, 1889, Abhandl. zur Geologischen Specialkarte Preussen Thuringischen Staaten, Berlin, vol. 10, pt. 1, p. 250, pl. 22, fig. 6 (Grimmerten, Germany; Lower Oligocene). Is probably *striata* Sowerby.

"*Cassis*" *angustana* Wrigley, 1934, Proc. Malacological Society London, vol. 21, no. 2, p. 118, fig. 21 (London Clay, Highgate; Eocene). Near *striata* J. Sowerby, 1812.

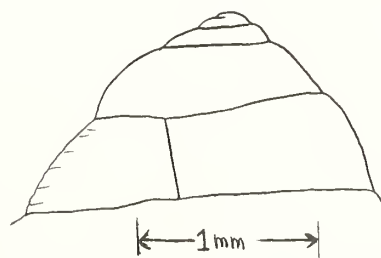


Plate 102. Nuclear whorls of *Phalium* (*Galeodosconsia*) *nupera* (Conrad, 1833). Eocene of southeastern United States.

North American

Cassis brevicostatus Conrad, 1834, Jour. Acad. Nat. Sci. Philadelphia, vol. 7, p. 146 (Claiborne, Alabama; Eocene); for complete treatment, see Palmer, 1937, Bull. Amer. Paleontology,

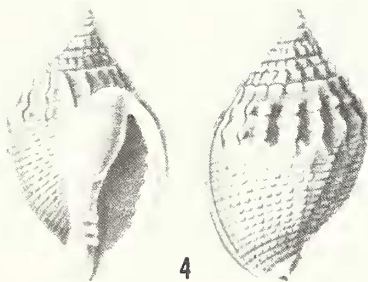
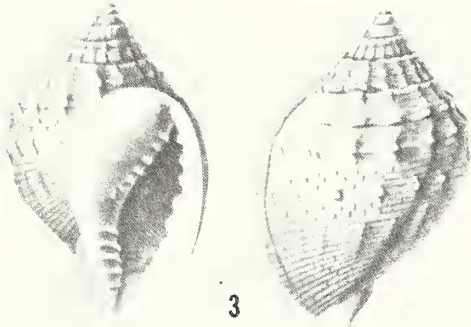


Plate 103. European members of *Phalium* (*Galeodosconsia*). Fig. 1, type of the subgenus, *P. (G.) striatulum* (Bellardi and Michelotti, 1841). Miocene of Europe. 27 mm. (from Hoernes and Auinger, 1884, pl. 14, fig. 14). Fig. 2, *P. (G.) calantica* (Deshayes, 1835). Eocene of the Paris Basin. 32 mm. (from Cossmann and Pissarro, 1911, pl. 34, fig. 165-4). Fig. 3, *P. (G.) striatum* Sowerby, 1812. Tertiary of northern Germany. 29 mm. (from Beyrich, 1854, pl. 10, figs. 1a, b). Fig. 4, *P. (G.) type of Cassis quenstedtii* Beyrich. 26.5 mm. (from Beyrich, 1854, pl. 10, figs. 2a, b).

vol. 7, no. 32, p. 248, pl. 31, figs. 4, 9-11, pl. 83, fig. 9. *Cassis globosum* Dall, 1890, is a synonym.

Phalium brevicostatum creolum Palmer, 1947, Bull. Amer. Paleontology, Ithaca, vol. 30, no. 117(sec. 2), p. 328, pl. 42, figs. 7, 8 (Moody's Branch marl, locality 10, Montgomery, Louisiana; Eocene).

Cassis (Phalium) globosum Dall, 1890, Trans. Wagner Free Inst. Science, Philadelphia, vol. 3, pt. 1, p. 161 (Upper Eocene of Mississippi, near Newton; and Ocala, Florida); 1892, *ibid.*, pt. 2, p. 262, pl. 20, figs. 6, 11. See Palmer, 1937, p. 248, is *brevicostatus* Conrad, 1834.

Cassis hodgii Conrad, 1841, American Journal Science, vol. 41, p. 346, pl. 2, fig. 10. Natural Well, Duplin Miocene of North Carolina. The type in A.N.S.P. no. 18860 is 29.2 mm. in length. It appears to be closer to *Galeodosconsia* than *Sconsia*. Also spelled *hodgei* by authors.

Buccinum sowerbii Lea, 1833, Contributions to Geology, Philadelphia, p. 164, pl. 5, fig. 169. Is a synonym of *Phalium (Galeodosconsia) nuperum* (Conrad). For details, see Palmer, 1937, Bull. 7, American Paleontology, no. 32, p. 253, pls. 31 and 83. Eocene of Alabama.

Cassis nuperus Conrad, 1833, Fossil Shells Tertiary Formations of North America, Philadelphia, vol. 1, no. 4, p. 46. For a complete synonymy, see Palmer, 1937, Bull. 7, American Paleontology, no. 32, p. 253, pl. 31 and 83. Eocene of Alabama.

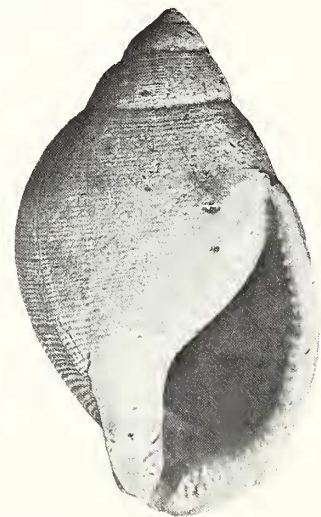


Plate 104. *Phalium (Galeodosconsia) hodgii* (Conrad, 1841). Miocene of North Carolina. 68 mm. (from Cossmann, 1903, pl. 6, fig. 3).

Subgenus *Semicassis* Mörch, 1852

Type: *Phalium bisulcatum* Schubert and Wagner, 1829

The shells in this subgenus are somewhat globular, rarely with former varices in the spire, usually with numerous spiral threads or incised lines on the outside, usually with rows of squarish, yellowish spots, with a wrinkled columellar shield, and a finely denticulated, thickened outer lip. The base of the outer lip lacks terminal spines, and the longitudinally threaded siphonal fasciole lacks the single, raised ridge found in *Echinophoria*. The operculum is fan-shaped and may be smoothish or strongly sculptured radially.

The subgenus *Tylocassis* Woodring differs only in having numerous small pustules on the columellar shield. *Phalium bandatum* subspecies *exaratum* Reeve serves as a morphological intermediate between *Phalium s.s.* and *Semicassis*.

The egg mass of *Phalium* (*Tylocassis*) *granulatum* (Born) from the Caribbean is illustrated on the first page of this monograph.

Dall (1909, p. 62) and Schenck (1926, p. 77) erroneously used the name *Bezoardica* Schumacher, 1817, for this subgenus, but Iredale (1927, p. 334) showed that this name is synonymous with *Phalium* Link, 1807. Iredale (1927, p. 334) considered *Echinophoria* Sacco, 1890, to be a synonym of *Semicassis* Mörch, but I believe it to be different.

Synonymy—

- 1852 *Semicassis* Mörch, *Catalogus Conchyliorum*. . . Yoldi, Copenhagen, p. 112. Type by subsequent designation by G. F. Harris, 1897, p. 198: *S. japonica* Reeve [which is *bisulcatum* Schubert and Wagner]. Cossman, 1903, p. 125 unnecessarily designated *Buccinum saburon* L. [Brug.]
- 1888 *Faurotis* Jousseaume, *Mem. Soc. Zool. France*, vol. 1, p. 188. Type by original designation: *F. faurotis* Jousseaume, 1888.
- 1927 *Antephalium* Iredale, *Records Australian Museum*, Sydney, vol. 15, p. 350. Type by original designation: *Cassid semigranosa* Lamarck, 1822.
- 1928 *Kahua* Marwick (subgenus of *Phalium*) *Trans. and Proc. New Zealand Inst.*, vol. 58, p. 482. Type by original designation: *P. (K.) skinneri* Marwick, 1928.

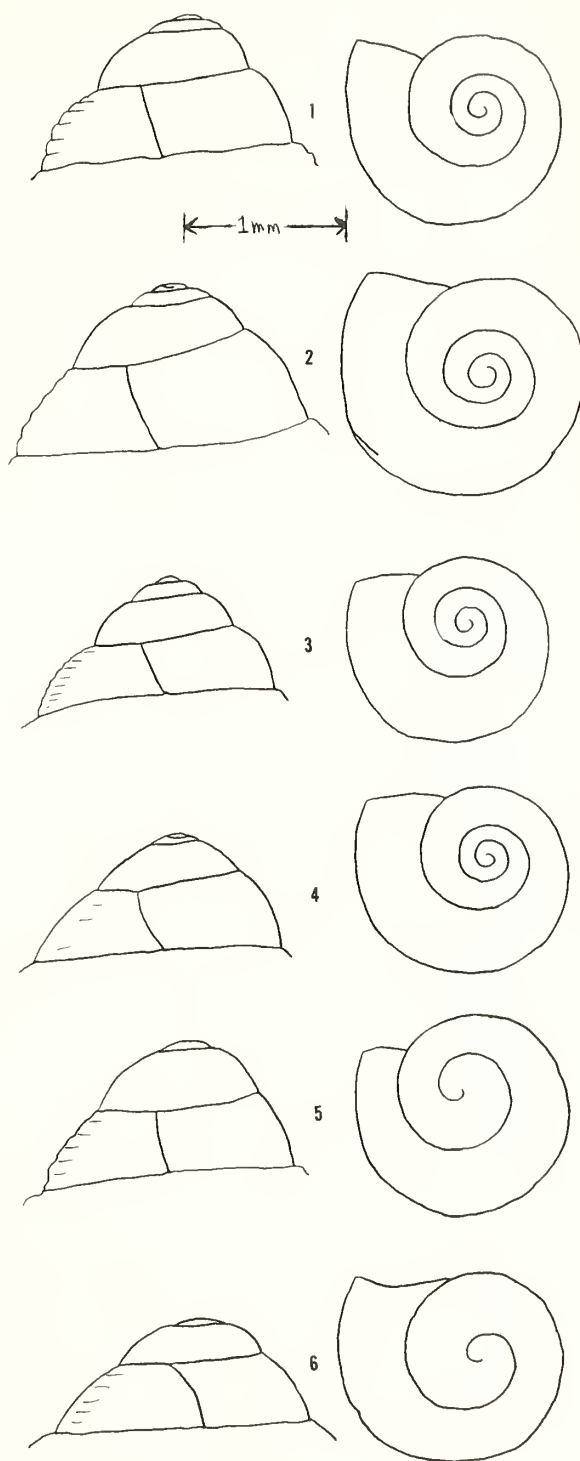


Plate 105. Nuclear whorls of *Phalium* (*Semicassis* and *Xenophalium*). Fig. 1, (*S.*) *bisulcatum* (Schubert and Wagner). Fig. 2, (*S.*) *granulatum* (Born). Fig. 3, (*X.*) *pyrum* (Lamarck). Fig. 4, (*X.*) *labiatum* (Perry). Fig. 5, (*X.*) *semigranosa* (Lamarck). Fig. 6, (*X.*) *sinuosum* (Verco).

Phalium bisulcatum
(Schubert and Wagner, 1829)

(Pl. 8, figs. 13-21; pls. 105-114)

Range—East Africa to the Marshall Islands and Japan to Australia.

Remarks—This widely distributed Recent species, known from eastern Asia and the East Indies during the Upper Miocene, Pliocene and Pleistocene, exhibits a remarkable array of forms, both in color and sculpture, which are difficult to ascribe to either genetic or ecological causes. Each colony appears to be unique in shell characters. Some forms, such as forma *diuturnum* Iredale, occur commonly in distantly located areas, such as in Australia, North Borneo and Japan, but are absent or perhaps very rare in the intervening areas. The only generalization I can draw is that larger forms exist in cooler waters, that more coarsely sculptured specimens occur in deeper waters where the bottom is muddy, and that smaller, more brightly spotted specimens occur in tropical areas where the water is shallow and the bottom is of coral sand. Many of these forms have received names.

More than one varix is seldom formed in this species, except in heavy, strongly lirate specimens from 50 to 100 fathoms in the Philippines, from 23 fathoms off Madagascar, from 20 fathoms in southern China (Hong Kong), the Bay of Bengal, and in some Japanese specimens. This was given the name *pfeifferi* Hidalgo, 1871, and "var, *minor*" Küster, 1857. This character may be associated with cool water. Some shells may bear a total of 6 varices.

The size, shape and color density of the squarish, reddish spots on the shell are very variable. The spots tend to be weak or obsolete in many localities, and in conjunction with closely packed, flattened spiral ridges, constitute what I refer

to as forma *diuturnum* Iredale which is prevalent in Australia, Malaya and Japan. The whole shell commonly has a grayish or bluish cast. Specimens of this form found along northern Australia are smaller, but not necessarily of a "narrower build" as stated by Iredale (1927, p. 335). The number of spiral ridges or lirae on the body whorl varies from 29 to 40 in Queensland shells, 29 to 49 in Hong Kong and 22 to 38 in Northern Territory, Australia, with no correlation with the degree of spotting, size of shell, occurrence of former varices, depth of water or geographical distribution. I find similar evidently uncorrelated variation in the degree of wrinkling on the columellar shield, globosity of the shell, thickness of the last varix, and the number of dentitions on the outer lip. Axial sculpture, causing a reticulation on the surface of the spire, appears in specimens which come from muddy bottoms at depths over 20 fathoms.

If these various combinations of forms were accepted and named as species, it would necessitate the description of several hundred new species. Considering the known existence of intergrades, the probable effect of environment, and the degree of speciation existing in other cassids from the Indo-Pacific and other parts of the world, I would think such a course of little taxonomic value.

Unfortunately, Schubert and Wagner's *bisulcatum* is based upon a rather uncommon form which is well-spotted and smooth on the last whorl, except for 2 or 3 rather strong cords below the suture which cause the shoulder to be tabulate. I have seen this form, whose shell varies from 30 to 50 mm. in length, from the Philippines, Dutch New Guinea, Andamans (*booleyi* Sowerby, 1900), and Madagascar. This form is so dominant and is so further modified in eastern Australia, that I have recognized it as



Plate 106. *Phalium (Semicassis) bisulcatum* (Schubert and Wagner, 1829). Variations in size, sculpture, shape and color

pattern in specimens from Maqueda Bay, Samar Island, Philippines. All natural size.

the geographical subspecies *sophia* Brazier, 1872.

E. J. Kuenzler (*in litt.* 1963) states that the only other organism taken in the bottom haul at the Eniwetok lagoon, Marshall Islands, was the echinoid "sea mouse", *Rhinobrissus hemiasteroides* A. Agassiz, 1879. This may be the food of *P. bisulcatum*.

Description—Shell 23 to 71 mm. (about 1 to 3 inches) in length, ovate-globose, smooth or spirally striate, thin- or thick-shelled, with or without 5 or 6 spiral rows of reddish to yellowish brown, squarish spots, and with a rugose or spirally lirate columellar shield. A very variable species. Nuclear whorls 3 to 3½, bulimoid, slightly tilted, smooth, glossy, white or tan. Early postnuclear whorls with 4 to 7 small, beaded, irregularly-sized, spiral threads. Last two whorls usually smoothly rounded, but may be slightly shouldered due to 2 to 4 strong spiral cords below the impressed suture. Body whorl may be smooth or with numerous fine, incised lines, or with numerous crowded, coarse, spiral cords which may be smooth or weakly beaded. Spire with 1 to 5 former varices. Color cream, whitish or bluish gray and with or without 5 or 6 spiral rows of small or large yellowish to reddish brown spots which may coalesce spirally or axially. Last varix of varying thickness, white or with brown or mauve color bars. Inside of outer lip white and with weak or strong, numerous, small teeth. Inside of aperture white, tan or brown. Parietal wall with a weak or fairly strong glaze. Columellar shield with a sinuous, elevated left edge, and bearing rugose, irregular, white lirae. True and false umbilicus deep, open and narrow. Channel posterior to the siphonal canal usually well-developed. Operculum yellowish and smoothish, except for concentric growth lines.

Measurements (mm.)—

length	width	no. whorls	
71.5	49.8	8	lectotype of <i>japonica</i> Reeve
71.0	46.2	8	large; Kyushu Id., Japan
68.0	44.0	8	holotype of <i>diuturnum</i> Iredale
59.0	39.5	6+	holotype of <i>nashi</i> Iredale
45.3	30.8	8	holotype of <i>booleyi</i> Sowerby
40.5	28.0	7	lectotype of <i>bisulcata</i> S. and W.
23.4	16.7	6	small; Jesselton, N. Borneo

Nomenclature—When Iredale in 1927 described his *diuturnum* from Australia, he interpreted Reeve's first application of the name *Cassis pila* on plate 5 of the *Conchologia Iconica* as technically a new name for figure 350, pl. 34, vol. 2 of Martini's *Conchylien-Cabinet* and for

vignette 18, figs. 1 and 2 on page 10. The latter is a reproduction of a living animal of Columnnae's "Buccini Neapolitani" from the Mediterranean [i.e., *Semicassis saburon* (Bruguère)]. Martini's figure 350 could be either *saburon* or the West Indian *Phalium granulatum* (Born). Martini's reference to the West Indies is taken from Valentyn (1773) and probably refers to the shell in figures 344 and 345, and not as Iredale supposed, to 350. However, the problem is not the true identity of these figures, but is whether or not Reeve's clumsy wording should be construed to mean that the name *pila* should apply to earlier, conflicting figures or be reserved for the shell he figured the next month, under the name of *pila*, on plate 9, figure 21. Everyone realizes that Reeve intended to name the shell from China in figure 21 as *pila*, and for this reason, I suggest that Reeve is saying that his not hitherto described species ("which I propose to distinguish by the name *C. pila*") only appears to correspond with Martini's figures. In fact, Reeve states that *saburon* (Reeve's species and figure 11) is well-illustrated by Martini's figure 350 and by the vignette 18. If Reeve had thought that his new *pila* was really represented by Martini's figures, he probably would have placed those references under the formal description of his *pila* on plate 9. I consider Reeve's *pila* on his plate 9, figure 12, and Iredale's *diuturnum* synonyms of *bisulcatum* Schubert and Wagner, 1829.

I disagree with Iredale's (1927, p. 336) interpretation of Schubert and Wagner's figures on their plate 223. I have seen their specimens in Copenhagen. None appears to be West Indian, except for figure 3083 which is *Cassis flammea* Linné. Figures 3077 and 3078 are the weakly-colored, spirally lirate form of *bisulcata* and are Iredale's form *diuturnum*. Figures 3084 and 3085 (*pomum* S. and W.) are the heavy, Mediter-

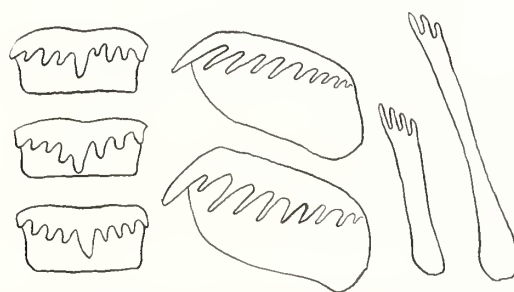


Plate 107. *Phalium (Semicassis) bisulcatum* (Schubert and Wagner). Radular variations in an immature specimen from Sagami Bay, Japan.



Plate 108. *Phalium (Semicassis) bisulcatum* (Schubert and Wagner, 1829). A malformed specimen from off Anping, western Taiwan Island. Courtesy of Mrs. Orville Davis. 43.2 mm. in length.

anean *saburon* (Bruguière). Figures 3079 and 3080 are *canaliculatum* (Bruguière). Figures 3081 and 3082 (*bisulcatum* S. and W.) are what Sowerby named *booleyi* in 1900.

The name "*persimilis* Kuroda MS" was introduced in 1955 and first validated with a description in 1959 by Kira in his "Coloured Illustrations of Shells of Japan". It refers to a moderately large, light-weight shell which is lightly spotted and lacks former varices. I have before me a suite of 9 specimens from Mogi, Nagasaki Prefecture, Japan, and consider them merely a form which is almost indistinguishable from the Australian form *diuturnum* Iredale. Two Mogi specimens are on our plate 5, figs. 20, 21. A specimen from Vatia, Fiji, kindly loaned to me by Walter O. Cernohorsky, is also very close to the form "*persimilis*".

Synonymy—

- 1815 *Buccinum areola* L., Burrows, Elements of conchology, London, pl. 16, fig. 2; 1820, Wodarch, Introd. Study Conchology, London, pl. 3, fig. 39.
- 1825 *Buccinum tessellatum* Wood, Index Testaceologicus, London, p. 105, no. 27, pl. 22, fig. 27 (Amboyna). Not *B. tessellatum* Gmelin, 1791; not *Cassis tessellata* Pfeiffer, 1840.
- ?1828 *Cassis scrobiculata* Menke, Synopsis Methodica Molluscorum, Pymont, p. 36 and 86 (ad Javam); 1830, ed. 2, p. 63 and 144. [nomen oblitum].
- 1829 *Cassis bisulcata* Schubert and Wagner, Conchyl.-Cab., Nürnberg, vol. 12, p. 68, figs. 3081, 3082 (no locality). [smooth form].

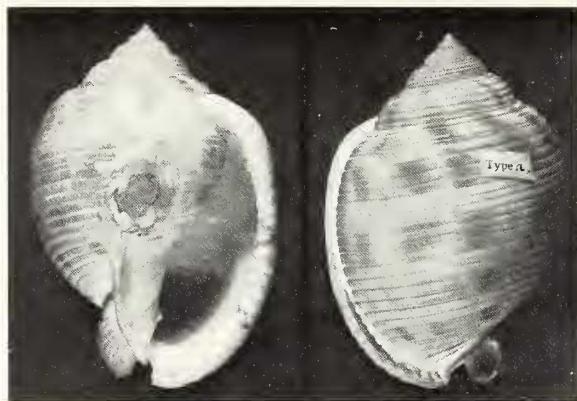


Plate 109. *Phalium (Semicassis) bisulcatum* (Schubert and Wagner, 1829). Holotype of *Cassis japonica* Reeve in the British Museum (Natural History). 71.5 mm. in length.

- 1829 *Cassis saburon* Lam., Schubert and Wagner, *ibid.*, p. 66, figs. 3077, 3078. [sulcate form; spotless].
- 1848 *Cassis pila* Reeve, Conchologica Iconica, vol. 5, Cassis, pl. 5 and pl. 9, fig. 21, (China) [sulcate; spotted; lightweight form]; 1942, Yen, Proc. Mal. Soc. London, vol. 24, pl. 17, fig. 105 of holotype.
- 1848 *Cassis japonica* Reeve, Conchologica Iconica, vol. 5, Cassis, pl. 9, fig. 23b (China and Japan).
- 1857 *Cassis saburon* Brug., Küster, Martini and Chemnitz System. Conchyl.-Cab., second series, vol. 3, pt. 1b, p. 38, pl. 51, figs. 7, 8.
- 1857 *Cassis pila* Reeve, Küster, *ibid.*, p. 39, pl. 51, figs. 9, 10.
- 1857 *Cassis nucleus* Küster, *ibid.*, p. 43, pl. 52, figs. 3, 4.
- 1857 *Cassis japonica* var. *minor* Küster, *ibid.*, p. 43, pl. 52, fig. 9 (Japanese coast).
- 1871 *Cassis pfeifferi* Hidalgo, Journal de Conchyl., Paris, vol. 19, p. 226 (in *insularis* Philippines?); 1872, *ibid.*, vol. 20, p. 143, pl. 7, fig. 2 [sulcate; spotted; heavy form].
- 1888 *Faurotis bisulcata* Sowerby, Jousseaume, Mém. Soc. Zool. de France, vol. 1, p. 188 [error in author].
- 1896 *Cassis pfeifferi* Crosse, Sowerby, Proc. Malacological Soc. London, vol. 2, p. 14 [error in authorship].
- 1900 *Cassis booleyi* Sowerby, Journal of Malacology, vol. 7, no. 7, p. 163, text fig. (Port Blair, Andaman Islands). [smooth; spotted].



Plate 110. *Phalium (Semicassis) bisulcatum* (Schubert and Wagner, 1829). Holotype of *Xenogalea nashi* Iredale in the Australian Museum no. C. 57789 from Sydney Harbour, Australia. 59 mm. (photos courtesy of D. F. McMichael).

- 1920 *Cassis* (*Semicassis*) *pila* Reeve, Tesch, Paläontologie von Timor, Stuttgart, vol. 8, pt. 14, p. 44, pl. 129, fig. 157 (Pliocene, Timor).
- 1927 *Semicassis diuturna* Iredale, Records Australian Museum, Sydney, vol. 15, p. 335, pl. 32, fig. 9 (Port Stephens, New South Wales, Australia).
- 1931 *Xenogalea nashi* Iredale, Records Australian Mus., Sydney, vol. 18, p. 214, pl. 23, fig. 18 (Sydney, New South Wales).
- 1933 *Cassis suburnon* [sic] var. *pila* Reeve, Yen, Second Ann. Report Marine Biol. Assoc. China, Peiping, pt. 1, p. 60 (Amoy, China).
- 1933 *Cassis japonica* Reeve, Yen, loc. cit., p. 61 (Amoy, China).
- 1943 *Phalium* (*Semicassis*) *pila* (Reeve), Altena, Leidsche Geolog. Mededeel., Leiden, vol. 13, p. 93 [fossil synonymies].
- 1955 *Semicassis persimilis* "Kuroda" Kira, Coloured Illustrations, Shells of Japan, Osaka, p. 43, no. 3, pl. 21, fig. 3 (nude name).
- 1959 *Semicassis persimilis* "Kuroda" Kira, loc. cit., 2nd ed., pl. 21, fig. 3, p. 43 (Japan, 10-20 fms.).
- 1960 *Semicassis pila* (Reeve), MacNeil, U.S. Geol. Survey, Prof. Paper 339, p. 58, pl. 13, figs. 2, 3 (Shinzato tuff, Okinawa).

Types—No type locality was given for *bisulcatum* Schubert and Wagner. We hereby designate Port Blair, Andaman Islands, as the type locality. The type is in the Zool. Mus. Copenhagen. The types of *pila* Reeve and *japonicum* Reeve are in the British Museum (Natural History) in London. The Australian Museum in Sydney contains the holotypes of *nashi* Iredale (C. 57789 and *diuturnum* Iredale (C. 53268). Kira's type of *persimilis* may be lost.

Selected records—(for other specimens examined, see solid dots on accompanying map) SOUTH AFRICA: Durban, Natal (J. H. Dale, Durban Mus.; Ponsonby, Brit. Mus.). ZANZIBAR: 8 fms., 2 mi. W.S.W. of Ras Mungive (A. J. Ostheimer, 3rd, ANSP). MADAGASCAR: 22 fms., 32 mi. S.W. of Nossibé (R. E. M. Ostheimer, R. W. Foster and M. Buerk, ANSP). PERSIAN GULF: 73 meters, of Sharjah, Oman Trucial (John Murray Exped., Sta. 72, Brit. Mus.). GULF OF OMAN: 43 and 52 fms., 47 to 25 mi. east of Dibbah, Saudi Arabia (Anton Bruun stations 255A and 262A). INDIA: Karikal (Dautzenberg coll'n., Mus. Royal Hist. Nat. Belgique); Madras (R. Winckworth, BM). BURMA: 37 fms., 35 mi. west of Tavoy Id., (Anton Bruun Sta. 36A, Mar. 30, 1963. 55 meters, 75 mi. W.S.W. of Akyab (Anton Bruun Sta. 49, Apr. 5, 1963). THAILAND (Andaman Sea): Patong Bay, Phuket (R. T. Abbott, Feb. 1963, ANSP). (Gulf of Siam); Koh Samet (H. M. Smith, USNM). MALAYA: Batu hitam, Pahang (R. D. Purchon, 1960, ANSP). JAPAN: Togi, west Honshu Id. (Brian Kane, 1966, ANSP). CHINA: Kwangtung and Sin-Tsung, Hainan Id. (A. D. Scarlato, Zool. Inst. Leningrad); Canton; Swatau (both Zool. Mus., East Berlin). PALAU IDS.: Malakal Harbor, Koror Id. (Johnson and Bridges, 1947, USNM). RYUKYU IDS.: Kaneko, Oki Id. (Anita Scott, coll'n.). PHILIPPINES: common throughout all the islands from 10 to 190 fathoms. 190 fms., Tayabas Bay, Luzon Id., Albatross Sta. 5374; 182 fms., N.E. of Tagola, Mindanao Id., Albatross Sta. 5519; 34 fms., off Tawi Tawi Id., Albatross Sta., 5152; also at other Albatross stations in the Philippines; Sta. 5187 (225 fms., dead); 5220 (50 fms., soft green mud); 5257 (28 fms., gray mud); 5272 (118 fms.); 5278 (102 fms.); 5279 (117 fms., gray mud); 5335 (46 fms., sandy mud); 5353 (148 fms.); 5369 (106 fms.); 5371 (83 fms., soft green mud); 5376 (90 fms., gray mud-

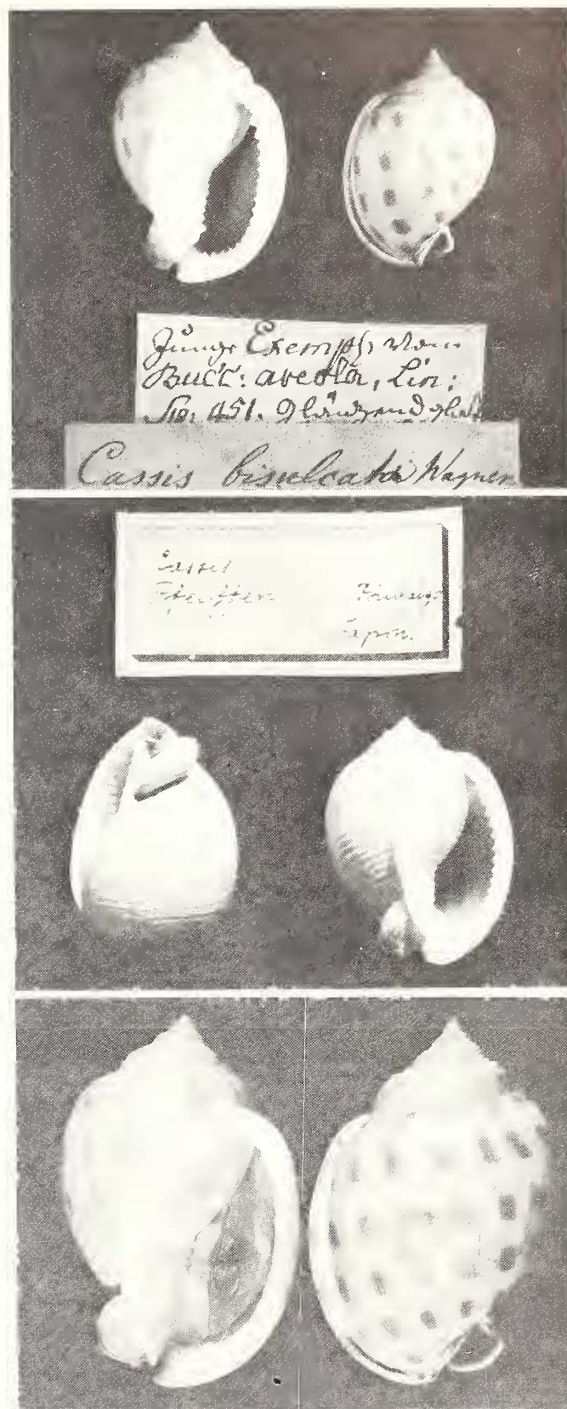


Plate 111. *Phalium* (*Semicassis*) *bisulcatum* (Schubert and Wagner, 1829). Top figs., syntypes of *Cassis bisulcata* Schubert and Wagner. Zool. Mus. Copenhagen. 40.5 mm. (left). Center figs., syntypes of *Cassis pfeifferi* Hidalgo, 1871, in Museo de Ciencias Naturales de Madrid. 51 mm. Bottom figs., holotype of *Cassis booleyi* Sowerby, 1900, Port Blair, Andaman Islands, in British Museum (Natural History). 45.3 mm.



Plate 112. *Phalium (Semicassis) bisulcatum* (Schubert and Wagner, 1829). Holotype of *Semicassis diuturna* Iredale, Australian Museum no. C. 53268, from Port Stephens, New South Wales, Australia. 68 mm. (photo courtesy of D. F. McMichael).

sand); 5426 (27 fms. dead); 5642 (37 fms., gray mud). INDONESIA: 37 fms., gray mud, Buton Straits, Celebes Id. (Albatross Sta. 5642) (all USNM). 44 meters, 140 mi. N.W. of Jakarta, Java (Galathea Sta. 457, 1952, Zool. Mus. Copenhagen). NORTH BORNEO: Tonjong Aru, Jesselton; Maruda Bay (both Mary Saul, ANSP). AUSTRALIA: 23 fms., off Legendre Id., Dampier Archip., Western Australia (C. S. Weaver and Mariel King, 1960, BPBM). 16 fms., off Flat Top Bank, 16 fms., off Arnhem Land, 18 fms., off Liverpool River, all Northern Territory (all Vernon Wells, ANSP). Off Evan's head, New South Wales (T. A. Garrard, MCZ). SOLOMONS: Ataa, Malaita Id. (van der Riet, ANSP). FIJI: Vatia wharf, Viti Levu

Id. (W. O. Cernohorsky coll'n). MARSHALL IDS.: 46 meters, sand and silt, lagoon, 2 mi. N.N.W. of Igurin Id., Eniwetok Atoll (E. J. Kuenzler, 1960, ANSP). BAY OF BENGAL: (all Anton Bruun Stations, International Indian Ocean Exped., Mar.-April, 1963) off Phuket Id., Sta. 19, 42 meters, Sta. 20, 58 meters in clay-mud; 30 mi. west of Twin Id., Burma, Sta. 22B, 274-293 meters in sand-mud, 12 mi. N.W. of Port Blair, off South Andaman Id., Sta. 28, 90 meters in sand; 25 mi. N.W. of Port Blair, Sta. 28c, 38 meters, sand; 35 mi. west of Tavoy Id., Burma, Sta. 36a, 68 meters, mud; 57 mi. N.W. of Tavoy Id., Sta. 37, 39 meters in sand; 35 mi. S.E. of Irrawaddy R., off Burma, Sta. 41a, 22 meters in gray mud; 17 mi. S.S.E. of Akyab, north Burma, Sta. 49, 55 meters in muddy sand; 10 mi. S.E. of Vizagapatnam, N.E. India, Sta. 89, 58 meters in sand.

Fossil Synonymy

- 1879 *Cassis herklotsi* K. Martin, Die Tertiärschichten auf Java, p. 45, pl. 8, figs. 7, 7a (Upper Miocene; Tjikarang, Java); 1908, K. Martin, Versl. Vergad. Kon. Akad. v. Wet., Afr. Nat., p. 9 (Sondé, Java; Pliocene); 1919, Unsere Palaeozool. Kenntnis von Java, pp. 88, 141, 154 (Pliocene; Java). [see pl. 113].
- 1899 *Cassis (Semicassis) pila* Reeve, var., K. Martin, Samml. Geol. Reichs-Mus. Leiden, N.F., vol. I, p. 154, pl. 24, figs. 356-359 (Sondé, Java; Pliocene); 1962, Dey, Palaeontologia Indica, Mem. Geol. Survey India, new series, vol. 36, p. 68, pl. 5, fig. 13 (Miocene; Quilon beds, Kerala, India).
- 1927 *Cassis (Semicassis) japonica* Reeve var. *minor* Kuster, P. J. Fischer, Paläontologie von Timor, Lief. 15, Abh. 25, p. 61, pl. 212, figs. 28a, b, 29a, pl. 213, figs. 29b, 30a, b (Ceram; Pliocene); 1931, Koperberg, Jaarb. Mij. Ned.-Indie for 1930, first Verhandl., p. 122 (Timor, Tertiary).
- 1943 *Phalium (Semicassis) japonicum herklotsi* K. Martin, Altena, Leidsche Geol. Mededeelingen, vol. 13, p. 95.
- 1943 *Phalium (Semicassis) pila* (Reeve), Altena, loc. cit., p. 93.
- 1948 *Phalium (Semicassis) pila* (Reeve), Cox, Schweizerische palaeont. Abhandl., vol. 66, p. 36, pl. 1, figs. 92, b (7 km. west of Dent Haven, N.E. North Borneo; Upper Miocene or Pliocene); 1942, Altena, Leidsche Geol. Mededeelingen, vol. 13, p. 93.
- 1899 *Cassis (Semicassis) rembangensis* K. Martin, Samml. Geol. Reichsmus. Leiden, Neue Folge, vol. I, pt. 1, p. 155, pl. 24, fig. 362 (Sedan and Punkte, Gunung Butak, Pamotan, Java [Pliocene]). Smooth form.

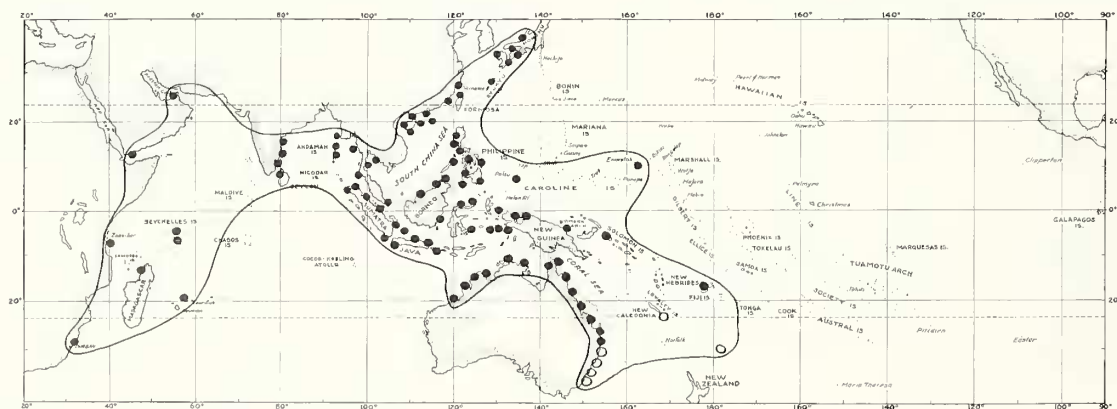


Plate 113. Geographical distribution of *Phalium (Semicassis) bisulcatum* (Schubert and Wagner) shown in solid dots.

The subspecies or possible hybrid, *sophia* (Brazier) are shown as open circles at the southeast range of *bisulcatum*.

- 1935 *Phalium (Semicassis) japonicum* Reeve, Nomura, Tohoku Imperial Univ. Science Reports, series 2, Geology, vol. 18, no. 2, p. 170 (Pliocene of Taiwan).
 1948 *Phalium (Semicassis) dalrymplei* Cox, loc. cit., p. 37, pl. 1, figs. 10a, b (7 km. west of Dent Haven, N.E. North Borneo; Upper Miocene or Pliocene).
 1962 *Cassis (Semicassis) quilonensis* Dey, loc. cit., p. 69, pl. 5, figs. 20, 26 (Miocene; Quilon beds, Kerala, India).

Fossil records—JAPAN: Lower Pliocene: Sirado Beds at Tennoyama, Totomi Prov., Honshu, (J. Makiyama, 1927, Mem. College Sci. Kyoto Imp. Univ., ser. B., vol. 3, no. 1, p. 72). PHILIPPINES: Upper Miocene-Pliocene at Cotabato, Mindanao Id. (W. D. Smith, 1913, pp. 254, 263, pl. 5, fig. 6). INDONESIA: Miocene, Pliocene and Pleistocene of Java, Sumatra, Ceram and Timor (see details in Altena, 1943, pp. 93-96, under *pila* and *herklotsi*). TAIWAN: Pliocene, Byoritu Beds of Wangwa, Kokwan, etc. (Nomura, 1935, vol. 18, p. 170).

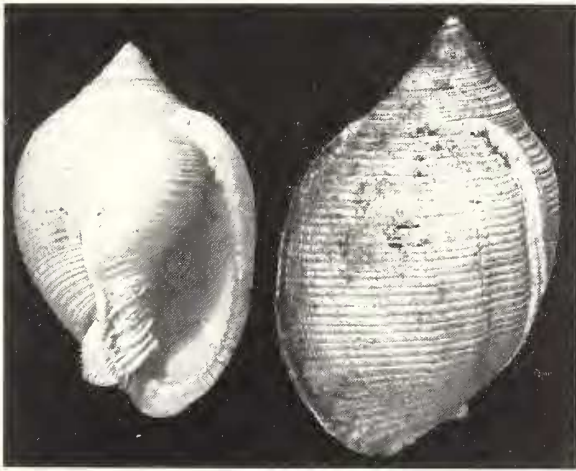


Plate 114. *Phalium (Semicassis) bisulcatum* (Schubert and Wagner, 1829). Miocene of Java, Indonesia. Holotype of *Cassis herklotsi* K. Martin, 1879.

Phalium bisulcatum subspecies sophia (Brazier, 1872)

(Pl. 8, fig. 12; pl. 115, figs. 1-8)

Range—Southern Queensland and New South Wales, Australia, and the Kermadec Islands.

Remarks—From southern Queensland to New South Wales, and evidently in the Kermadec Islands, there is a distinctive form which tends towards a large size, tabulate shoulders, smoothish surface and axial color bands. The shells are puzzling in two respects. Smaller, heavier specimens (off Moreton Bay, Brisbane) bear a striking resemblance to variants of *bisulcatum* from Madagascar and the Andamans; and larger, lighter-weight specimens (off Tweed Head and Trial Bay, New South Wales) give the impression that they are the result of hybridization with the cool-water *pyrum* complex. In 1910, Iredale noted this latter relationship by considering *sophia* as a subspecies of *pyrum* but he later (1927) raised *sophia* to species rank. *S. sophia* exhibits variations in the labial teeth (from strong to a few weak ones or even obsolete) and in the degree of rugosity of the columellar shield (from strong rugae as in typical *bisulcatum* to a smoothish columella as in many *pyrum*). Northern specimens have the squarish spots of *bisulcatum*, but southern shells show a gradual increase in irregular, axial brown flames as in some *pyrum*. Short of breeding experiments, the placement of *sophia*, whether as a full species, as a subspecies of *bisulcatum* or as a hybrid, *bisulcatum* X *pyrum*, is purely arbitrary.



Plate 115. *Phalium (Semicassis) bisulcatum* subspecies *sophia* (Brazier, 1872). Variations in shape, color patterns and sculpturing. Figs. 1, 2, holotype of *Cassis sophia* Brazier in

the Australian Museum no. C. 30751. 79 mm. Figs. 3-8, specimens from off New South Wales and Queensland, Australia. (courtesy of Joy Kerslake).

I am following Iredale (1927, p. 343) in using the spelling "*sophia*" which was the original one. A year after he described the species, Brazier corrected the spelling to "*sophiae*."

Description—Shell 58 to 79 mm. (2¼ to 3 inches) in length, globose, thin- to thick-shelled. Cream to whitish background with 6 spiral rows of squarish and reddish brown spots which may be axially joined with wavy, broad, reddish brown flames or bands. Whorls 7 to 8, weakly or strongly flattened or tabulate just below the suture where there are 3 to 6 irregularly-sized, smoothish, rounded, spiral cords. Parietal shield and its left edge moderately to strongly developed. Columella with oblique sulcations and broken rugae, but in some specimens half-smooth or entirely smooth. Outer lip or varix thin or thick, in the latter case having weak or strong, white, spiral dentitions. Inner and upper parietal wall may or may not bear 2 or 3 short, oblique rugae. Siphonal canal short, recurved and faintly tinged with lavender-brown in back of the rounded, posterior opening (not black-tipped). Canal bordered posteriorly by a well-marked gutter which runs posteriorly into the deep, true umbilicus. False umbilicus narrow and deep. Base of body whorl with 3 to 6 microscopic, incised spiral lines.

Habitat—Dredged in 40 to 80 fathoms, presumably on sand bottoms.

Measurements (mm.)—

length	width	no. whorls	
79.0	65.0	5+	large; holotype, Australian Mus.
78.0	62.0	6+	large; Trial Bay, New South Wales
74.1	51.9	8	average; Tweed Head, N.S.W.
74.0	52.0	8	average; Southport, Queensland
61.5	43.7	7	small; Caloundra, Queensland
60.5	42.5	8	small; Trial Bay, N.S.W.
57.9	37.3	7	small; Moreton Bay, Brisbane, Qld.

Synonymy—

- 1872 *Cassis sophia* Brazier, Proc. Zool. Soc. London for 1872 (Nov.) p. 617, pl. 44, fig. 2 (under Grassy Head, mouth of Macleay River, New South Wales).
 1873 *Semicassis (Casmaria) sophiae* Brazier, loc. cit., p. 838, no. 8.
 1910 *Cassidea pyrum sophiae* Brazier, Iredale, Proc. Mal. Soc. London, vol. 9, p. 71 (Sunday Island, Kermadec Islands).
 1915 *Cassidea pyrum* Lamarck, Oliver, Trans. and Proc. New Zealand Inst., vol. 47, p. 529 (Kermadec Islands).
 1918 *Phalium sophia* Brazier, Hedley, Journ. Royal Soc. New South Wales, vol. 51, p. M. 67.
 1927 *Xenogalea sophia* Brazier, Iredale, Records Australian Mus., vol. 15, p. 343, pl. 32, fig. 12, the holotype.

Types—The locality is Grassy Head, Macleay River, New South Wales, Australia. The holotype

of *sophia* is in the Australian Museum in Sydney, no. C. 30751.

Records—KERMADEC ISLANDS (600 mi. N.E. of New Zealand): Sunday (or Raoul) Island (Iredale, 1910, p. 71). AUSTRALIA: QUEENSLAND: Peel Id., Moreton Bay, near Brisbane (Iredale, 1927, p. 344); Caloundra (Joy Kerslake coll'n; Aust. Mus.); Southport (Joy Kerslake coll'n); off Cape Moreton (ANSP, pl. 5, fig. 12). NEW SOUTH WALES: Trial Bay; Tweed Head (both Joy Kerslake coll'n.); off Green Cape (Iredale, 1927, p. 344; Macleay River (Aust. Mus.); off Port Jackson, Sydney (Aust. Mus.).



Plate 116. *Phalium (Semicassis) canaliculatum* (Bruguière, 1792). Holotype, 49.0 mm. in length. Mus. d'Hist.Nat.Genève.

***Phalium canaliculatum* (Bruguière, 1792)**

(Pl. 8, figs. 5, 6; pl. 116)

Range—Bay of Bengal (and the Philippines?).

Remarks—*P. canaliculatum* (Bruguière) is very closely related to *S. bisulcatum* (Schubert and Wagner), but differs in having a deep, wide, V-shaped channel at the suture in the last two whorls. Its otherwise smooth body whorl bears 16 to 18 fine, incised spiral lines which are evenly spaced apart. The varix is usually heavy and recurved. In coloration and rugosity of the columellar shield, it is similar to many specimens of *bisulcatum*.

Authentic records of this species exist for the western section of the Bay of Bengal, from Cey-

lon north to Madras. I question the Philippines records in the literature (de Elera, 1896, p. 225), because these may well be based upon specimens of *bisulcatum*. Staub reported this species from the east side of Borneo (1916, p. 125), but I believe this and other uses of the name *canaliculatum* for probable specimens of *bisulcatum* (Schubert and Wagner) are due to the use of Küster's poor figures (1857, vol. 3, part 1b, pl. 43, figs. 3 and 4).

The only shell difference between *bisulcatum* and *canaliculatum* is the presence of a sub-sutural channel in the latter. Some workers may wish to consider this difference as only of sub-specific importance. The species is common offshore in the region of Madras, India (Hornell, 1951, p. 23).

Description—Shell 35 to 53 mm. (about 1½ to 2 inches) in length, globose, with a thin but strong shell; deeply channeled at the suture; with a denticulate outer lip, and with a well-developed, rugose parietal shield. Nuclear whorls 3, bulimoid, smooth, opaque and milk-white. First few postnuclear whorls with 6 to 8 minute, spiral threads which may or may not be crossed by retractively slanting, axial threads. Last whorl with 17 to 20 incised, spiral lines. Suture deeply channeled below. Color of shell cream with 4 or 5 spiral rows of small, squarish, light yellow-orange spots. Outer lip with 17 to 20 fairly strong white teeth on the inner edge. Columellar shield strongly rugose. True and false umbilicus small, but deep. Left edge of parietal shield wavy, but not with projections. Operculum unknown.

Measurements (mm.)—

length	width	no. whorls	
53.5	35.0	7	large; India
49.0	35.9	5+	Bruguière's type
45.0	31.0	7	average, Ceylon
34.5	24.0	7	small, Ceylon

Types—No type locality was given by Bruguière. Lamarck gave "Ceylon" which we designate as the type locality. Bruguière's type is in the Museum de Genève (1962).

Synonymy—

- 1792 *Cassidea canaliculata* Bruguière, Encyclopédie Méthodique, vers, vol. 1, pt. 2, p. 423 (locality unknown).
 1822 *Cassis canaliculata* Brug., Lamarck, Anim. sans Vert., vol. 7, p. 228 (Côtes de Ceylan); 1829, Schubert and Wagner, Neues Syst. Conchl.-Cab., vol. 12, p. 67, pl. 223, figs. 3079, 3080; 1834, Kiener, Coquilles Vivantes, Paris, vol. 7, Cassis, p. 32, pl. 14, fig. 28.

1935 *Phalium (Semicassis) canaliculatum* (Bruguière), Bayer, Zoologische Mededeelingen, vol. 18, p. 101; 1942, Gravely, Bull. Madras Gov't. Mus., new series, Nat. Hist., vol. 5, no. 2, p. 42 and 97.

Records—INDIA: Madras (R. Winckworth, BM) (Melvill and Standen, 1898, Jour. of Conch., vol. 9, p. 44; Hornell, 1951, p. 23; Gravely, 1942, p. 42; Adyar, near Madras (Zool. Mus. Amsterdam); Karikal (Dautzenberg, coll'n., Bruxelles). CEYLON: Sweat Bay, Trincomalee (A. J. Kohn, Yale Peabody Mus.). PHILIPPINES: Mindoro Id.; Cebu Id.; Dapitan, Mindanao Id. (all de Elera, 1896, p. 225). [probably *bisulcatum* S. and W.J. Roxas, (Capiz), Panay Id. (H. M. Woolsey, coll'n., Yale Peabody Mus.) [locality accurate?].

Fossil records—None reported.

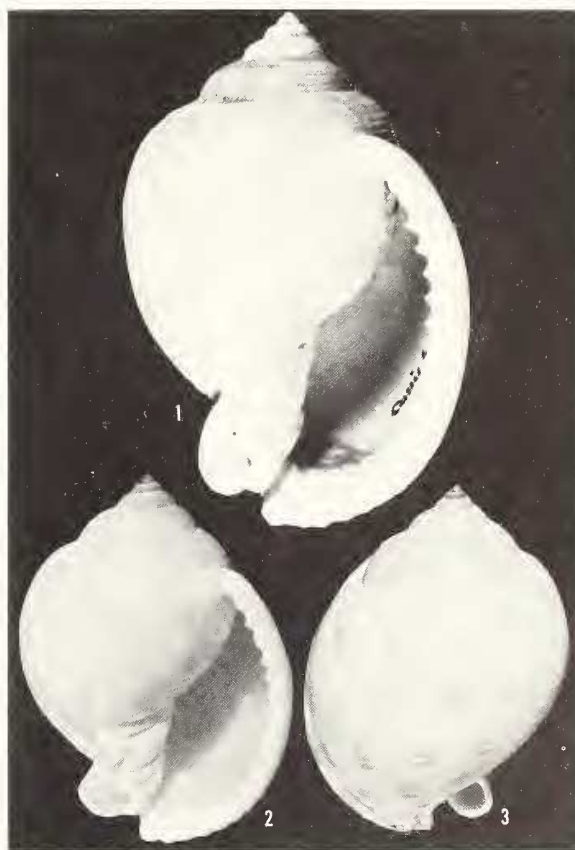


Plate 117. *Phalium (Semicassis) faurotis* (Jousseaume, 1888). Fig. 1, holotype of *Faurotis faurotis* Jousseaume, 1888, Mer d'Aden, 49.1 mm. Mus. d'Hist. Naturelle Paris. Figs. 2, 3, specimen from Scottsburgh, Natal, South Africa, 43 mm.

***Phalium faurotis* (Jousseaume, 1888)**

(Pl. 8, figs. 3, 4; pls. 117-119)

Range—Western end of the Indian Ocean.

Remarks—This uncommon species is readily distinguished from its nearest ally, *bisulcatum* (Schubert and Wagner), by its bluish black or purple-brown apex, in having 3 to 5 large, rounded knobs or fingertip projections on the left border of the columellar shield, and in lacking a



Plate 118. Operculum of *Phalium* (*Semicassis*) *faurotis* (Jousseaume). Durban, South Africa. Shell, 49 mm.; operculum, 14.8 mm.

relatively wide channel or groove at the base of the last whorl just posterior to the lower, right margin of the siphonal canal. *S. faurotis* is variable in its degree of spiral sculpturing and intensity of color-spotting, but I have seen no completely smooth forms, nor fresh specimens which lacked coloration. I have not seen specimens over 66 mm. in length. It is the only species of Cassidae with darkly colored nuclear whorls. Its operculum is strongly fimbriated with about 22 long, chitinous denticles.

I believe Cuming's locality and that of a specimen in the ANSP collection of "Manila, Luzon Island" are probably erroneous. Azpeitia (Moros) in 1925 figured Hidalgo's type of *Cassis crossei* and pointed out that the origin of that specimen was the Red Sea and not the Philippines. It is a synonym of *faurotis* (Jousseaume). It is for this reason that Hidalgo did not include *crossei* in his 1904-1905 "Catalogo Moll. Test. de las Islas Filipinas."

Habitat—This species has been dredged on gray sand bottoms from 6 to about 160 fathoms. Rarely, it is cast ashore. It occurs with *P. bisulcatum*.

Description—Shell 37 to 61 mm. (1-1/2 to 2-1/2 inches) in length, globose, solid, cream with reddish spots, with finger-like projections on the left edge of the columellar shield and with a dark apex. Nuclear whorls 3, bulimoid, glossy, and purple-brown. Postnuclear whorls with 5 to 8 minute spiral threads between which are numerous, microscopic axial growth lines which may produce weak beading. Last whorl cream to tan with a blush of grayish on the dorsal side, with 5 spiral rows of square, reddish brown spots, and with numerous spiral, incised lines. Outer lip with 14 to 18 small, white teeth. Columellar shield rugose and with 3 to 5 large, rounded knobs on the left edge. Umbilicus open; false umbilicus narrower and sealed in some specimens. The channel posterior to the siphonal canal is very narrow. Operculum strongly fimbriate.

Measurements (mm)

length	width	no. whorls	
65.7	43.1	8	large; Muscat
61.0	41.0	8	large; Aden
51.0	35.0	8	Aqaba, Red Sea
48.6	32.0	8	lectotype of <i>faurotis</i>
37.5	26.1	7	small; Indian Ocean

Types—The type locality is Aden. I am choosing Jousseaume's specimen in the Museum d'Histoire Naturelle in Paris as the lectotype. Its measurements are given above. I was unable to locate Hidalgo's type of *crossei*.

Synonymy—

- 1848 *Cassis bisulcata* Schubert and Wagner, Reeve, Conch. Icon., vol. 5, Cassis, pl. 3, figs. 6a, 6b (Manila, Luzon Id.; Cuming) [?locality erroneous]; 1859, Chenu, Manuel de Conch., vol. 1, p. 207, fig. 1128.
 1888 *Faurotis faurotis* Jousseaume, Mémoires Société Zoologique de France, vol. 1, p. 188 (east of Aden).
 1896 *Cassis crossei* Hidalgo, Journ. de Conchyl., vol. 44, p. 217, (in insulis Philippinis); 1923, Azpeitia (Moros), Revista de la R. Acad. de Cienc. Exact., Físicas y Nat. de Madrid, vol. 21, p. 75; reprint, 1925, p. 155, pl. 1, fig. 4 (in color).
 1939 *Cassis* (*Phalium*) *bisulcata* Sch. et Wg., Moazzo, Mém. l'Inst. d'Egypte, vol. 28, p. 164 (Moya Soukh, Suez).

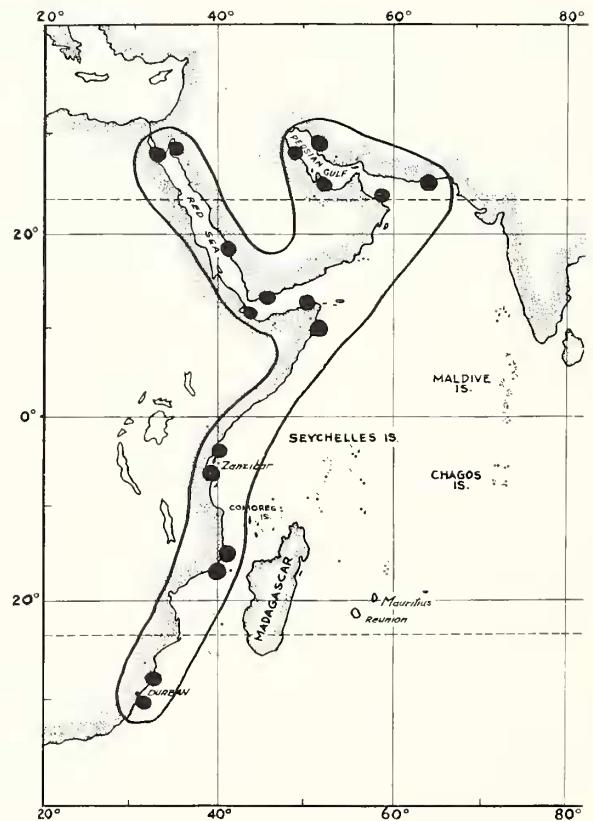


Plate 119. Geographical distribution of *Phalium* (*Semicassis*) *faurotis* (Jousseaume).

Records—SOUTH AFRICA: NATAL: Durban (H. C. Bur-nup, USNM; J. J. Ponsonby, Brit. Mus.); Scottsburg (Helen Boswell, coll'n.). PORTUGUESE EAST AFRICA: 20 meters, Nacala (F. B. Steiner, ANSP); Porto Amelia (W. E. Old, Jr., ANSP). ZANZIBAR: 1½ mi. N.W. of Chango Id.; 1½ mi. W.S.W. of Ras Mungive, 8 fms. (both A. J. Ostheimer, 3rd, ANSP). FRENCH SOMALIA: Loyada, near Djibouti (N. Lavergn, ANSP). SOMALIA: Candala (Carl Gans, MCZ); 47 meters, off Ras Biannah (Anton Bruun Sta. 9-453) ADEN: Kaymaksur (Rijksmus. Leiden). RED SEA: off Yemen, 375 meters, John Murray Exped. Sta. 207 (BM); Eilat, Gulf of Aqaba (A. Hadar, coll'n.). PERSIAN GULF: Safaniya, Saudi Arabia, 8 fms. (Jeanne Johnson coll'n); Kuwait (USNM); Isle of Khark, near Bushehr, Iran (G. Thorson, 22 meters, Mar. 24, 1937, Mus. Zool. Copenhagen). Muscat, Oman (D. T. Bosch, ANSP); 52 fms., 47.1 mi. east of Duhat Sharjah, Gulf of Oman. Anton Bruun station 255A (MCZ) WEST PAKI-STAN: near Karachi (Abdullah Mohammed El-Husseini, 1963, ANSP).

Phalium umbilicatum (Pease, 1860)

(Pl. 8, figs. 10, 11; pl. 120)

Range—Known only from the Hawaiian Chain to Midway Island. Also in the Pleistocene on Lanai Island, Hawaii.

Remarks—This rare Hawaiian species is characterized by its heavy, globose, spirally-corded shell and by its highly ornamented operculum. The spiral cords are strongly developed even on the parietal wall and on the inside wall of the last whorl. The lower half of the apical whorls are usually colored mauve or purplish. In opercular characters, it most resembles *P. faurotis* of the western Indian Ocean.

This species was described twice, first by Pease in 1860, and later by E. A. Smith in 1904. It would appear that the same type specimen was used in the description.

Description—Shell 22 to 62 mm. (about 1 to 2½ inches) in length, solid, globose, spirally corded, brownish cream with weak or absent spottings. Nuclear whorls 3, glassy, smooth, bulimoid, slightly tilted, the upper half whitish, the lower half mauve or brownish purple. Apical whorls with 4 to 6 beaded, spiral threads. Last whorl rotund and bearing 17 to 19 strong, smooth, flat-topped, spiral cords. Aperture somewhat constricted. Varix heavy, recurved, its apertural side being enamel white and bearing 17 to 19 strong, white, sometimes bifurcate, spiral teeth which continue inside the aperture on the inside of the last whorl; its posterior side is wavy and marked with narrow, mauve stripes. Columellar shield well-developed and strongly liriate

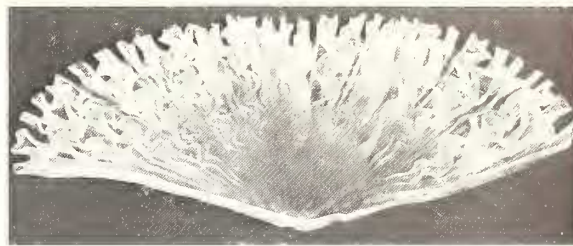


Plate 120. Operculum of *Phalium (Semicassis) umbilicatum* (Pease). 25.8 mm. Oahu Id., Hawaii. (photo by Jay Sacks).

and rugose. Parietal wall with spiral cords. True umbilicus very deep; false umbilicus narrower but as deep. Channel posterior to the siphonal canal deep and fairly broad. Color of shell brownish cream with a purple-gray blotch on the dorsal side of the penultimate whorl; weak orange-tan spots may be present on the last whorl. Operculum yellow and with numerous radial, tubular folds.

Measurements (mm.)—

length	width	no. whorls	
62.5	43.0	9	Pease coll'n. (MCZ)
55.9	39.5	8	Type of <i>fortisulcata</i> (BM)
38.1	26.0	7	small; Keehi, Oahu Id.
21.6	18.0	7	small; Keehi, Oahu Id.

Types—The type locality for *fortisulcata* is Kauai Island. Smith's type of *fortisulcata* is in the British Museum (Natural History) in London. Pease's type, also from the Cuming collection, is probably the same specimen. E. A. Smith read the name on Cuming's label of "Hanalei", a town on Kauai, and supposed erroneously that it was a manuscript name of "*Cassis hanclei*". The Museum of Comparative Zoology, Cambridge, Mass., contains two possible co-types of *umbilicata* from the Pease collection.

Synonymy—

- 1860 *Cassis umbilicata* Pease, Proc. Zool. Soc., London, for 1860, p. 436 (Sandwich Islands; Cuming collection).
 1904 *Cassis (Semicassis) fortisulcata* E. A. Smith, Proc. Malacological Soc. London, vol. 6, p. 21, fig. (Kauai, Hawaiian Ids.; Cuming collection).
 1958 *Semicassis fortisulcata* (E. A. Smith), Tinker, Pacific Sea Shells, Tuttle Co., p. 86, lower left figs.

Records—MIDWAY: R. A. Garratt, 1943 (USNM); Calif. Acad. Sci.; BPBM. KAUAI: Hanalei Mus. Cuming, Brit. Mus.). OAHU: Honolulu Harbor dredgings; 53 to 211 fms. off south coast, Albatross Station 3810; 33 to 50 fms. off Waiki, Albatross Station 5508 b (all USNM); 10 to 40 fms. off Honolulu (Th. Mortensen, 1915, Zool. Mus. Copenhagen); 20 to 50 fms. off Keehi Lagoon (C. S. Weaver and Mariel King, 1959). MAUI: 10 fms., mud, off Lahaina (C. S. Weaver and Mariel King).

Fossil Records—PLEISTOCENE: 550 ft. alt., Lanai Island (Harold Stearns, USNM).

***Phalium multisectum* (Finlay, 1924)**

Range—Upper Pliocene, North Island, New Zealand.

Remarks—I agree with Powell (1928, p. 642) that this species should be placed near the Recent *bisulcatum* Schubert and Wagner, 1829 (of which *diuturnum* Iredale is a synonym). The longitudinal (axial) striae on the outside of the siphonal canal (fasciole) are characteristic of the *bisulcatum* group. However, the small nodules on the shoulder are unusual for Indo-Pacific *Semicassis*, and are reminiscent of the *Tylocassis* complex of the Recent Mediterranean and Caribbean. The possible relationship of *multisectum* with *Xenophalium thomsoni* should not be overlooked, for the latter species sometimes has rugae on the columellar shield and the general sculpture of the outer shell is sometimes similar to that of *multisectum*. Hutton's original description which was without an illustration was "*Cassis striatus*, sp. nov. Ovato-ventricose; spire rather concave; body whorl obsoletely plicated in front, and distantly spirally striated; spire spirally striated, cancellated by fine transverse [axial] ribs; columella rugose, outer lip smooth." Length, 1.1 inches; width, .8 inch. Type locality; Wanganui. In 1924, Finlay renamed this homonym as *multisectum*. Powell (1928, p. 642) illustrates and records additional specimens from Castlecliff (53 × 37 mm.) and Kai Iwi (34 × 23 mm.). This species is lighter in structure than *skinneri* Marwick, 1928.

***Synonymy*—**

- 1873 *Cassis striatus* Hutton, Cat. Tertiary Mollusca and Echinodermata of New Zealand, Wellington, p. 8 (Wanganui, Shakespeare Cliff). Non Sowerby, 1812.
 1924 *Cassidea multisecta* Finlay, Proc. Mal. Soc. London, vol. 16, p. 101. New name for *Cassis striatus* Hutton, 1873, non Sowerby, 1812.
 1928 *Semicassis multisecta* (Finlay), Powell, Proc. Trans. New Zealand Inst., vol. 59, p. 642, pl. 74, figs. 13, 14.

***Phalium skinneri* Marwick, 1928**

(Pl. 121)

Range—Lower Miocene, Chatham Islands, New Zealand.

Remarks—This solid, globose, 41 mm.-long cassid is very distinctive, and closely resembles the Recent European *saburon* in shape and apertural features. It differs in having strong axial threads which give the surface a rugose finish. The parietal shield is heavily callused as in

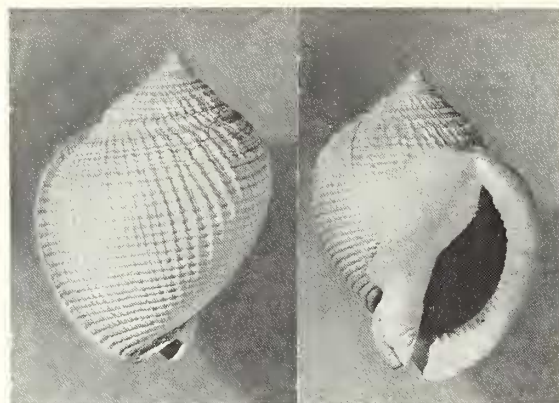


Plate 121. *Phalium (Semicassis) skinneri* Marwick, 1928. Lower Miocene, Chatham Islands, New Zealand. Holotype, 41.5 mm. (photos courtesy of the New Zealand Geological Survey).

saburon, but has a peculiar, U-shaped embayment on the left side, such as found in some Australian species. I can see no justification in retaining the subgenus *Kahua* which Marwick erected for this species. It seems to possess a combination of *Semicassis*, *Tylocassis* and *Xenophalium* characters.

Description—Shell (41 × 31 mm.) thick and strong; spire less than one-third height of aperture. Protoconch tectiform of about four smooth whorls with small nucleus. Post-embryonic whorls four, slightly convex on spire. Suture impressed. Sculpture: first whorl with two obsolete cords towards top of whorl; second with an additional thread near suture, all crossed by strong growth lines, on later whorls many additional spirals appear but the three primaries can be traced on body though upper is divided into 4, middle into 2, and lower into 2; interstices with additional threads (top one with 4, one stronger), below the third cingulum are 20 strong, broad spiral cords, with narrower interstices, some of the top ones being double. The spirals are regularly cancellated by strong bevelled ridges. Aperture deeply notched below; fasciole indistinctly spirally striated. Outer lip reflexed and much thickened to form strong varix, dentate within. Inner lip thickened, practically filling umbilicus but with no projecting platform; bearing about 16 waved threads of which 6 are on columella (from Marwick, p. 482).

***Synonymy*—**

- 1928 *Phalium (Kahua) skinneri* Marwick, Transactions and Proceedings New Zealand Institute, Wellington, vol. 58, p. 482, fig. 132 on p. 505 (Pitt Island, Whenuataru Peninsula, Chatham Ids., New Zealand; Tertiary).

Phalium microstoma (von Martens, 1903)

(Pls. 122-123)

Range—Deep-sea off Tanganyika to Somalia, East Africa (200-1134 meters).

Remarks—This species is known from only a few specimens, and it appears to be related to *S. craticulatum* Euthyme of South African waters. *S. microstoma* is characterized by its rather heavy shell, by its evenly-ovoid shape, by the 24 to 27 rather strong, even-sized spiral cords on the body whorl, by the very rugose columellar shield and by the strong spiral teeth which cross the thick outer lip. Like *craticulatum*, it has a rugosely toothed ridge on the inner, lower section of the columella. I examined von Marten's type series in East Berlin and decided that his holotype was an immature specimen. A fragment of a paratype shows the mature character of a rugose lower columellar shield. The type which is a dead specimen shows a hint of 4 or 5 spiral rows of yellowish brown spots, and a specimen, also dead, from the John Murray Expedition Station 110, shows about 24 mauve-brown, narrow stripes on the reflected outer lip. Fresh specimens bear 5 spiral rows of red-brown squares on the body whorl.

Description—Shell 48 to 65 mm. (about 2 to 2-1/2 inches) in length, solid, evenly-ovate, and with numerous, flattish, spiral lirae which are separated by interstices of half their width. Color pale grayish white with 3 to 5 diffused reddish brown bands or rows of subdued yellowish brown spots. Nuclear whorls 3-1/2, bulimoid, white and smooth. Post-nuclear whorls 5, the last bearing 24 to 27 flattish spiral cords of which the upper 2 or 3 may be slightly beaded. Suture simple and slightly impressed and ascending a little near the aperture. Spire convex-conic. Aperture 2/3 the total length of the shell, rather narrow. Outer lip thick, glossy, reflected, crossed by about 24 spiral teeth which continue weakly on the inside of the body whorl. Posterior edge of outer lip weakly crenulate and with 24 to 26 narrow, mauve-brown stripes. True umbilicus minutely open; false umbilicus usually sealed. Channel narrow and deep behind the siphonal canal. Parietal wall spirally corded, lightly glazed. Columellar shield strongly and unevenly pustuled. Inner lower columella edge with a high, gnarled or toothed, white ridge. Operculum unknown.

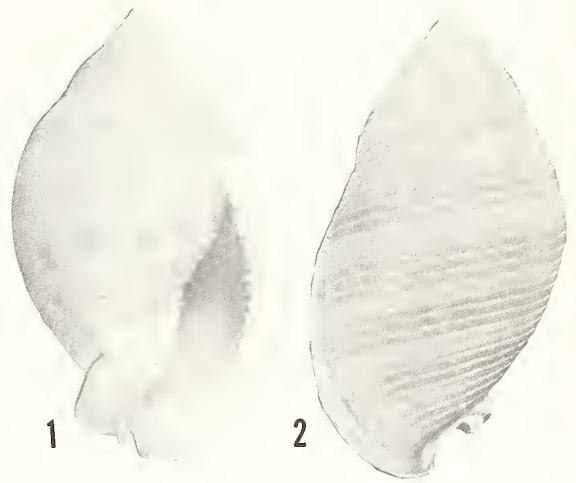


Plate 122. *Phalium (Semicassis) microstoma* (von Martens, 1903). Fig. 1, 100 meters, 40 miles east of Dar es Salaam, Tanzania. 57.8 mm. in length. Fig. 2, slender form, 200 meters depth. 58.3 mm.

Measurements (mm.)—

length	width	no. whorls	
65.5	40.1	9	large; off Pemba Island
52.0	38.5	7	holotype of <i>microstoma</i>
48.0	29.6	7	40 mi. E. of Dar-es-Salaam

Synonymy—

- 1903 *Cassis microstoma* von Martens, Wissenschaft, Ergebn. Deutschen Tiefsee-Exped., "Valdivia", vol. 7, pt. A, p. 112, pl. 3, fig. 12.
 1935 *Phalium microstoma* (Martens), Bayer, Zoolog. Mededeel, Leiden, vol. 18, p. 103.

Types—The holotype and paratypes of *Cassis microstoma* are in the Zoological Museum in East Berlin (1962). The type locality is "Valdivia station 254, near the coast of Somalia, off Brava in 977 meters in depth on blue mud (S. Lat. 0° 29'; W. Long. 42° 47')."

Records—TANGANYIKA: 30 mi. off Dar-es-Salaam (6° 34' S; 30° 35' E), 404 meters, Valdivia Sta. 242 (Berlin Museum). Just west of Pemba Id. (5° 03' 42" S; 30° 15' 24" E), 329 meters, John Murray Exped., Sta. 110, 1934 (Brit. Mus.); just west of Pemba Id. (5° 38' 54" S; 39° 15' 42" E), 212 meters, John Murray Exped. Sta. 106, Jan. 12, 1934. A fragment only. (Brit. Mus.); about 40 miles east of Dar-es-Salaam (6° 51' S; 39° 54' E), 100 meters, Anton Bruun Sta. 9-422; about 41 miles east of Dar-es-Salaam, 200 meters, bottom temp. 13.93° C, Anton Bruun Sta. 9-423. SOMALIA: (type locality, see above); 250 mi. east of Mogadiscio (1° 49' N; 49° 29' E), 1134 meters, Valdivia Sta. 256; 20 mi. east of Chiambon (1° 40' S; 41° 47' E), 693 meters, Valdivia Sta. 251 (both Berlin Mus.).

Fossil records—None reported.



Plate 123. *Phalium* (*Semicassis*) *microstoma* (von Martens, 1903). Original figure of holotype. 977 meters depth, off Somalia, East Africa.

Phalium sufflatum (Tenison-Woods, 1877)

Range—Miocene-Pliocene of Victoria, Australia.

Remarks—This delicate inch-long *Semicassis* from the Miocene-Pliocene is quite possibly a progenitor of the Recent *semigranosum* (Lamarck) found now along the southern coasts of Australia and in Tasmania. Pritchard (1896, p. 106) stated that *transennum* Tate, 1889 is undoubtedly a synonym of *sufflatum*. A description of the latter is:

“Protoconch of two and a half smooth, depressed turns, gradually increasing in size from the initial portion, abruptly separated from the succeeding whorl. The cancellate ornament, so well developed on the body-whorl of the adult, commenced to form in the earliest part of the brephic stage. Spire elevated, subangulate at the shoulder; suture accompanied by a small, acute ridge; aperture oval-oblong, obtuse posteriorly, and rounded in front; outer margin thickened, reflected, and dentate within; columellar expansion smooth, forming a thin plate anteriorly; columella twisted, and having several irregular plications, with here and there a tubercle anteriorly. A characteristic feature of the shell is the fine cancellate ornament. Length, 29mm.; breadth, 17 mm.; length of aperture and canal, 19 mm.”

The type locality is “Eocene: Muddy Creek, Victoria”. Mrs. Joy Kerslake sent me a fossil specimen from Balcomb Bay, near Mornington, Victoria.

Synonymy—

- 1877 *Cassis sufflatus* Tenison-Woods, Papers Royal Soc. Tasmania for 1876, pp. 93, 94 (Table Cape).
- 1889 *Semicassis transenna* Tate, Trans. and Proc. Royal Soc. South Australia, vol. 11, p. 166, pl. 8, fig. 2 (Lower beds at Muddy Creek; blue clays at Schnapper Point; calciferous sandstones, River Murray Cliffs near Morgan; Table Cape).
- 1896 *Semicassis sufflatus* Tenison-Woods, Pritchard, Proc. Royal Soc. Victoria, vol. 8, new series, p. 106; 1897, Harris, Cat. Tertiary Mollusca, pt. 1, p. 199.
- 1958 *Semicassis* (*Antephalium*) *sufflata* (Tenison-Woods), Ludbrook, Transactions Royal Society South Australia, vol. 81, p. 52 (Janjukian-Dry Creek Sands; Gippsland, Victoria and Adelaide, South Australia).

Phalium mekranicum (Vredenburg, 1925)

Range—Upper Miocene, Mekran Beds of Gwadar, Talar Mountains, India.

Remarks—The original specimens are poorly preserved but resemble low-spired, smoothish *P.* (*Semicassis*) *bisulcatum*. In length they vary from 28 to 36 mm. Vredenburg remarked that “this shell, like several other fossil forms, illustrates the difficulty of distinguishing, at times, between *Semicassis* and *Bezoardica* [*Phalium*].”

Synonymy—

- 1925 *Cassidea* (*Semicassis*) *mekranica* Vredenburg, Memoirs Geol. Survey India, vol. 50, pt. 1, p. 267, pl. 3, figs. 7-9 (Mekran beds: north of Talar Gorge, on the road from Kej to Gwadar, base of the sandstones constituting the Talar Mountains).

Phalium oligocalanticum (Vredenburg, 1925)

Range—Oligocene, Nari Beds in Sind, India.

Remarks—This 1½-inch (30-39 mm.), globular-ovoid species is characterized by numerous, fine, spiral, beautifully beaded threads on the last whorl. The top row of beads creates a crenulated suture. The columellar shield bears close-set, transverse ridges. Vredenburg gave a very lengthy description and likened this species to *Galeodea calantica* Deshayes from the Upper Eocene of the Paris region, which, however, is more coarsely noduled and lacks the transverse *Semicassis*-like ridges on the columellar shield. The sculpturing of *oligocalantica* closely resembles that of the Recent *Galeodea leucodoma* Dall from Japan.

Synonymy—

- 1925 *Cassidea* (*Semicassis*) *oligocalantica* Vredenburg, Memoirs. Geol. Survey India, vol. 50, pt. 1, p. 263, pl. 3, figs. 3-5; pl. 4, fig. 5 (Nari of Bhagothoro Hill in Sind).

Phalium sculptum J. de C. Sowerby, 1840

(Pl. 124)

Range—Miocene Gaj of Kutch, northwest India.

Remarks—This small, 1¾-inch cassid has the shape of a somewhat compressed *P. (Semicassis) bisulcatum*. Vredenburg (1925, pp. 271-274) gave a lengthy description of the shell and allied it, erroneously I believe, to the typical *Phalium*. Because of the absence of a swelling and strong teeth on the central part of the outer lip and because Vredenburg's description of the nuclear whorls fits that of *Semicassis* rather than *Phalium* (*s.s.*), I am placing it near such species as *bisulcatum*. The shell lacks former varices, as do many other *Semicassis*. Vredenburg erroneously added Cossman's "*Bezoardica strigata* Gmelin" (1903, pl. 6, fig. 9) from the Pliocene of Karikal, India, to the synonymy of *sculptum*. Cossmann's is undoubtedly a broken specimen of *Phalium (Phalium) glaucum* Linné.

P. sculptum also resembles *P. exarata* Reeve from the Recent, but the latter lacks longitudinal threads on the siphonal fasciole.

Synonymy—

1840 *Cassis (Cypraeacassis) sculpta* J. de C. Sowerby, Trans. Geol. Soc. London, series 2, vol. 5, p. 329, pl. 26, fig. 21 and explanation to plates (Soomrow, Kutch, N.W. India).

1925 *Cassidea (Bezoardica) sculpta* Sowerby, Vredenburg, Memoirs Geol. Survey India, vol. 50, pt. 1, p. 271-274 (Gaj of Kutch; Rampur).



Plate 124. *Phalium (Semicassis) sculptum* (Sowerby, 1840). Lower Miocene, Gaj Beds, Kutch, India. Holotype, 43 mm. Brit. Mus. (Nat. Hist.) no. GG 3057 (photo courtesy of P. Nuttall).

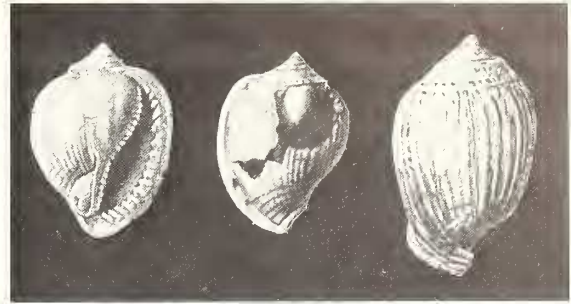


Plate 125. *Phalium (Semicassis) denseplicatum* (K. Martin, 1916). Lower Miocene, West Progo beds of Java, Indonesia, 35 mm. (from K. Martin, 1916, pl. 2, figs. 42, 42a, 43).

Phalium denseplicatum (K. Martin, 1916)

(Pl. 125)

Range—Lower Miocene; West Progo of Java, Indonesia.

Remarks—Although only ten specimens are known, this appears to be a quite distinct 35 mm.-long *Semicassis* characterized by well-developed axial riblets. The suture is bordered below by a well-beaded spiral cord, a feature rarely seen in *Semicassis*. K. Martin's figure 43 shows a shell somewhat resembling the *Cypraeacassis testiculus* complex, but Martin says the specimen was considerably misshaped in preservation. The numerous small teeth along the entire inner lip is an unusual feature.

Synonymy—

1916 *Cassis (Semicassis) denseplicata* K. Martin, Samml. Geol. Reichsmus. Leiden, Neue Folge, vol. 2, pt. 6, p. 243, pl. 2, figs. 42, 42a, 43 (Gunung Spolong and Kali Kemedjing, Lower Miocene, West Progo beds of Java).

Phalium turricula Dall, 1909

(Pl. 126)

Range—Upper Miocene and Lower Pliocene of Oregon.

Remarks—Schenck (1926, p. 79) remarks that "the 15 spirals on the body whorl, absence of intercalary threads, and large size [80 mm.] characterize this species." The ribs bear numerous, small, squarish nodules. Dall's original description reads:

"Shell large, moderately thick, with an unusually elevated spire, with five sculptured whorls and a smooth nucleus of about two and a half whorls; axial sculpture of (on the penultimate whorl about 20) faint, obscure, somewhat flexuous ridges, chiefly noticeable from the nodula-



Plate 126. *Phalium (Semicassis) turricula* Dall, 1909. Holotype. 80 mm. Tertiary of Oregon.

tions which occur when the raised spirals cross them; the ridges are almost wholly absent from the last half of the last whorl; faint incremental lines also occur; spiral sculpture of (between the suture 4, on the last whorl 15) narrow raised revolving ridges with much wider interspaces but no intercalary small threads; where the ridges cross the axial ridges they are more or less undulated and swollen, the peripheral ridge on the spire has these projections particularly marked; there is no spiral striation; the suture is wound on the fourth spiral and, when the latter is nodulous, is undulated more or less; the type specimen has two varices, which is exceptional in this group and may be an individual aberration; aperture longer than wide, the outer lip thickened and reflected, internally denticulate; body with a callus which is raised at its anterior margin; canal short, deep, strongly reflected, with a deep wide sulcus behind it; the outer lip is constricted just before forming the varix. Altitude, 80 mm.; maximum diameter, 50 mm."

Synonymy—

- 1909 *Phalium (Bezoardica) turricula* Dall, U. S. Geol. Surv. Prof. Paper, 59, p. 63, pl. 4, fig. 6 (Coos Bay, Oregon; holotype USNM no. 153898); 1926, Schenck, Univ. Calif. Publ., Bull. Dept. Geol. Sci., vol. 16, p. 79, pl. 14, fig. 1; 1942, Weaver, Univ. Wash. Publ. Geol., vol. 5, p. 410, pl. 81, fig. 3; pl. 101, fig. 4 (holotype re-figured).

Phalium egberti Schenck, 1926

Range—Lowermost Oligocene, Olympic Peninsula, Washington State.

Remarks—Weaver (1942, p. 411) notes that "this moderately large [25.5 mm.] species differs from the other species of the genus in the Northwest in the presence of closely set spiral primary and secondary ribs which are crossed by fairly well-developed fine unequally spaced longitudinal ribs. Faintly developed nodes are present on the angulated part of the upper surface of the body whorl." Schenck's original description reads:

"Shell thick, mediumsize, globose, with acute spire about one-half height of body whorl. This ultimate whorl rounded, not sharply angulated. Callus smooth, thin, and quite adherent except anteriorly. Varices indistinct. Reflected anterior canal with deep sulcus behind siphonal fasciole. Sculpture: spire whorls marked by fairly distinct spiral threads crossed by faint growth striae. On body whorl spirals strap-like, distinct anteriorly but becoming progressively indistinct posteriorly; interspaces shallow; growth striae developing into fine threads on crossing spiral sulcations so as to give shell finely reticulated appearance. Halfway between the greatest convexity of body whorl and the suture is row of small nodes, with two other rows of incipient nodes anterior to first row. Dimensions: Type specimen, altitude 25.5 mm., greatest convexity 16 mm."

Synonymy—

- 1926 *Phalium (Bezoardica) egberti* Schenck, Univ. Calif. Publ., Bull. Dept. Geol. Sci., vol. 16, p. 80, pl. 13, fig. 7 (Woodman Station, Discovery Bay, Olympic Peninsula, Wash.; holotype no. 79, Geol. Dept. Stanford Univ., L. S. J. U., loc. N. P. 148); 1942, Weaver, Univ. Washington Publ. Geol., vol. 5, p. 411, pl. 81, fig. 4 (holotype re-figured).

Phalium iani Schenck, 1926

Range—Middle Oligocene, Willapa River Valley, Pacific Co., Washington.

Remarks—Although this species was placed in *Liracassis* (i.e. *Mauicassis*) by Moore (1963, p. 31), I am following Schenck's (1926) and Weaver's (1942) instincts and placing it in *Phalium*. It is obviously related to such other *Phalium* of the same region as *egberti* Schenck and *aequisulcatum* Dall. Although these *Phalium* have occasional varices and are very similar in shape and sculpture to several Recent *Semicassis*,

the parietal shields are poorly developed, perhaps because of immaturity or poor preservation.

Schenck's original description was: "Shell fairly thick, medium size, globose; acute spire half the height of body whorl; five whorls; appressed sutures; short, reflected canal; fairly distinct varices. Sculpture: Consists of broad, flat revolving lines (11 on body whorl) with well-defined equal interspaces in which there is one (sometimes two) intercalary thread; on upper part of body whorl longitudinal lines form two rows of low nodes, about 20; on early whorls, axial ridges appear to develop earlier than the nodes. Dimensions: Type specimen, altitude 30 mm. (part of canal lacking); greatest convexity 19.5 mm. Plate 13, figures 9, 10, 11, show variations in size." Weaver (1942, p. 411) added a note that "the adult forms of this species are smaller than the others from the Northwest. The species resembles somewhat *P. aquisulcatum* but possesses fewer and wider spiral ribs and has two spiral rows of tubercles on the upper surface of the body whorl and sometimes three rows on the penultimate."

Synonymy—

- 1926 *Phalium* (*Bezoardica*) *iani* Schenck, Univ. Calif. Publ., Bull. Dept. Geol. Sci., vol. 16, p. 80, pl. 13, figs. 8-11 (near Menlo, Pacific Co., Wash.; holotype in Cal. Acad. Sci. 1747); 1931, Etherington, *ibid.*, vol. 20, p. 102; 1942, Weaver, Univ. Wash. Publ. Geol., vol. 5, p. 411, pl. 81, fig. 5 (holotype re-figured).
1963 ?*Liracassis* *iani* Schenck, E. J. Moore, U. S. Geol. Surv. Prof. Paper, 419, p. 31 (Montesano formation, Miocene, Washington).

Phalium aquisulcatum Dall, 1909

Range—Upper Miocene and Lower Pliocene of Oregon and Washington States.

Remarks—Weaver (1942, p. 410) says that "this species may be distinguished from *P. turricula* Dall in its smaller size, the presence of the single intercalary thread, and in having 19 instead of 15 spiral ribs. The spire is proportionately lower than in *P. egberti* Schenck and it lacks the somewhat reticulated sculpture and slightly developed nodes on the body whorl of that species." Dall's original description reads:

"Shell of moderate size [45 to 60 mm.], solid, heavy, ovate, with about five whorls beside the (decollate) nucleus; suture distinct, not channeled; sculpture of (on the last whorl 19) even, flat, straplike, raised, subequal spirals, separated

by channeled, narrower equal sulci or interspaces most of which carry a single minute intercalary thread, which on the base is as a rule slightly nearer the posterior side of the channel in which it lies; there are faint traces of fine spiral striation, and the posterior four or five of the major spirals are somewhat beaded or granulated by axial sulci which do not appear in the channels; the varices except the terminal one are inconspicuous and irregular; two specimens, including the largest, show none; the figured specimen, which is smaller though better preserved, has indications of two besides the terminal varix; aperture longer than wide, subovate; outer lip reflected and thickened, internally dentate; body with a thin smooth callus (not in the figured specimen); canal deep, short, twisted, recurved, with a deep smooth sulcus behind it. Altitude of figured specimen, 45 mm.; of a larger but still immature individual (decollate), 60 mm.; maximum diameter, respectively, 30 and 39 mm."

Synonymy—

- 1909 *Phalium* (*Bezoardica*) *aquisulcatum* Dall, U.S. Geol. Surv. Prof. Paper, 59, p. 63, pl. 5, figs. 1, 4 (Coos Bay, Oregon; holotype, USNM no. 153896); 1926, Schenck, Univ. Calif. Publ., Bull. Dept. Geol. Sci., vol. 16, p. 79, pl. 13, figs. 5, 6, 12-16; 1942, Weaver, Univ. Wash. Publ. Geol., vol. 5, p. 409, pl. 81, fig. 2 (holotype re-figured) (Grays Harbor Co., Wash.).

Phalium oregonense (Dall, 1909)

Range—Middle Oligocene, Tunnel Point sandstone, Oregon and Washington.

Remarks—The fact that this species has the general shape and spiral ridges of some *Semicassis*, together with a short canal which is deeply excavated, twisted, more or less plicate, and has a deep channel behind it, leads me to place it among the *Phalium* (subgenus *Semicassis*) and not in *Galeodea* (as done by Weaver and by Durham) or *Liracassis* (i.e., *Manicassis*) by E. J. Moore (1963). Other species of *Phalium*, such as *egberti* Schenck and *iani* Schenck also occur in the Oligocene of the same general area. The strong spiral ribs occur in the Recent *Phalium whitworthi* Abbott of Western Australia, and I do not think that feature would justify erecting still another genus.

Dall's original description reads: "Shell thin, globose, strongly spirally sculptured, with about five whorls exclusive of the nucleus; earlier whorls with three or four, last whorl with about

11 major spiral ridges, squarish, often irregularly squarely nodulous, with wider channeled interspaces, smooth, or containing one or more smaller intercalary ridges; the posterior major spiral runs close to the suture, giving it a channeled effect; the spirals on the apical whorls are often reticulated by obscure axial riblets subnodulous at the intersections, but these disappear on the later whorls, though the major spirals often continue to show irregular nodulation; last whorl much the largest, terminating in the adult in a slightly reflected and thickened outer lip with obscure denticulations on its inner edge; canal short, deeply excavated, with a deep sulcus behind it, twisted and more or less plicate; a thin wash of callus on the body. Altitude of shell, 69 mm.; of last whorl, 60 mm.; maximum diameter 51 mm. Another specimen measures, respectively, 75, 64, and 53 mm."

Weaver (1942, pl. 81, fig. 1) illustrated a specimen, possibly immature, from a cut in the bank at Olympia Foundry, South Seattle, in a bluff along the east side of Duwamish Valley, King Co., Washington (Oligocene). E. J. Moore (1963, p. 30) asks if this might not be the Empire formation of the Pliocene.

Synonymy —

- 1909 *Eudolium oregonense* Dall, U.S. Geol. Surv. Prof. Paper, 59, pp. 71, 72, pl. 7, fig. 7 (Coos Bay, Oregon). Holotype, USNM 153895.
 1942 *Galeodea oregonense* (Dall), Weaver, Univ. Wash. Publ. Geol., vol. 5, p. 409, pl. 81, fig. 1, pl. 101, fig. 12 (holotype re-figured).
 1962 *Liracassis oregonensis* (Dall), E. J. Moore, U.S. Geol. Surv. Prof. Paper, 419, p. 30 (Pliocene? of Oregon).

Phalium glabratum (Dunker, 1852)

This species appears to be limited to the Western Pacific. It is characterized by a thin, lightweight but strong, glossy shell; by its elongated shape; by the rather narrow aperture which is bounded by a narrow but strong, smooth varix; by its narrow but deep umbilicus; and by the distinct, microscopic beading on the first 2 or 3 post-nuclear whorls. The species may be divided into three well-defined subspecies:

glabratum glabratum (Dunker, 1852)-limited to the central area of the species' distribution in the Philippines, Indonesia, and New Guinea. Left margin of columella shield only slightly indented; shell glossy white, with 7 or 8 prominent splotches of light-brown just below the suture, and with a pure white or yellowish varix. (Compare with *Casmaria ponderosa* forma *quadrata* (Link) which has no umbilicus nor beaded early whorls).

glabratum angasi (Iredale, 1927)-limited to the northern and eastern coasts of Australia. Left margin of columellar shield strongly indented in the area of the true umbilicus. Shell glossy translucent-cream with a suffusion of purplish tan on the dorsal sides of the whorls; subsutural blotches absent or very weak; varix white or yellowish.

glabratum bulla Habe, 1961-limited to the southern half of Japan to southeast China and Hawaii. Similar to *angasi*, but with the left margin of the columellar shield only slightly indented, and with 16 to 18 fine, purplish mauve stripes on the varix.

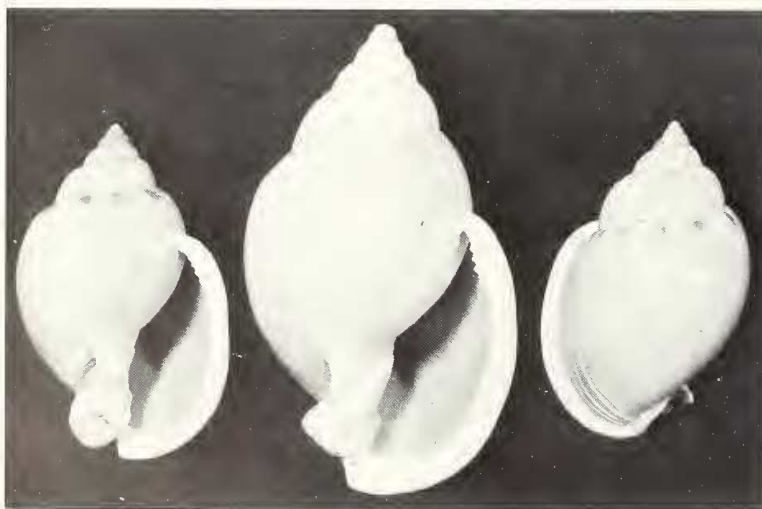


Plate 127. *Phalium (Semicassis) glabratum glabratum* (Dunker). Three specimens from the Moluccas, Indonesia.

Zool. Mus. Amsterdam, Netherlands. Shell at right is 47.7 mm. in length.

**Phalium glabratum subspecies
glabratum (Dunker, 1852)**

(Pl. 127)

Range—Southwest Pacific in the Philippines, Indonesia, and Melanesia.

Remarks—The typical subspecies is very rare. I have seen only seven specimens in American and European collections. It is distinguished from its neighboring subspecies in Japan and Australia by the bright, yellow-brown blotches just below the suture and by the great sharpness of the minute prickles on the inner edge of the outer lip. It may be distinguished from *Casmaria ponderosa* Gmelin, forma *quadrata* (Link) by its narrow true umbilicus and slit-like false umbilicus and by its microscopically beaded early post-nuclear whorls.

The ship "Albatross" dredged a broken specimen at station 5311 in 88 fathoms, off Pratas Island, 200 miles southeast of Hong Kong which somewhat intergrades between *glabratum* and the Japanese subspecies, *bulla* Habe. I have provisionally identified it as a *bulla*. A specimen from Kei Island in the Banda Sea, north of Australia, has a quite well indented left columellar edge which suggests an intergrade with Darwin, N.W. Australia, specimens. A Darwin specimen of the subspecies *angasi* (Iredale) has subdued subsutural blotches resembling those of typical *glabratum*. For these reasons I consider *angasi* and *bulla* to be geographical subspecies of the centrally located *glabratum*.

Habitat—Rare and dredged by Th. Mortensen (station 30) in 40 meters on a sand bottom (off Kei Island, Banda Sea).

Description—Adult shell 33 to 61 mm. (about 1-1/4 to 2-1/2 inches) in length, thin-shelled, light in weight, but strong; elongated; glossy enamel white with 7 or 8 rectangular blotches of yellow-brown just below the suture; with a small, deep true umbilicus and a narrow, slit-like false umbilicus. Whorls 7 to 8. Nuclear whorls bulimoid, 3, glossy, white, smooth; the first post-nuclear whorl bears 6 or 7 spiral, beaded threads, but in succeeding whorls these spiral lines disappear except for a single weakly beaded thread just below the finely impressed suture. Body whorl glossy, smooth and white. There is a blush of mauve on the dorsal side of penultimate whorl. The entire apex bears only 8 to 13 subsutural squarish, yellow-brown blotches. Aperture relatively narrow. Varix narrow, strong, slightly

recurved to form a gutter behind, white to yellowish, and with about 14 to 17 spiral, fine teeth on the inner edge which terminate as sharp, minute prickles. Columellar shield poorly developed, with numerous, spiral wrinkles. Left edge of columellar shield slightly thickened and slightly sinuate or indented. True umbilicus narrow, round, very deep; false umbilicus slit-like, deep, and bordered on the lower, inner edge by a sharp, pointed projection of the columella. Interior of aperture white to tan-cream. Base of shell with 2 to 4 weak or strong spiral, incised lines. Soft parts and operculum unknown.

Measurements (mm.)—

length	width	no. whorls	
61.0+	35.4	6+	large; near Cebu Id., Philippines
52.1	30.0	7+	no locality; ANSP
47.7	29.5	8	Moluccas
33.8	21.0	8	small; Kei-Doelah Id., Banda Sea

Synonymy—

1852 *Cassis glabrata* Dunker, Zeitschrift für Malakozool., 9th year, p. 62 (Zanzibar); 1858, Dunker's Novitates Conchologicae, series 2, vol. 1, p. 35, pl. 11, figs. 1, 2 (eastern Africa). [non *glabrata* Meuschen, 1787, which, however, is non-binomial].

Types—I was unable to locate Dunker's type in the Berlin Museum, the Senckenburg Museum, or the British Museum. Dunker's figured specimen, also not located, measured 68 x 37 mm. The type locality, according to the sea captain, Albert Rodatz, who brought it to Dunker, is "Zanzibar", but I question its accuracy.

Records—PHILIPPINES: near Cebu Id. (E. Zambo, legit. 1961; T. Montgomery); 18 fms., off Tawi Tawi, Albatross Sta. 5164 (USNM). INDONESIA: Molucca Islands (Zoolog. Mus. Amsterdam); 1 mi. off the northwest end of Kei-Doelah Id., Kei Ids., S.E. Banda Sea; Th. Mortensen station 30, trawled in 40 meters on sand and shell bottom associated with numerous crinoids, sponges and gorgonians (Zoolog. Mus. Copenhagen). [Salmon's 1948, p. 163, record of *glabratum* from Obock, French Somalia, is based upon a smooth specimen of *Casmaria ponderosa* subspecies *bicolor* Dautzenberg.]

Fossil records—None recorded.

**Phalium glabratum subspecies
angasi (Iredale, 1927)**

(Pl. 8, fig. 9; pl. 128)

Range—Northwestern Australia to Queensland and south to northern New South Wales, Australia.

Remarks—The comparative diagnostic characters of this Australian subspecies are given above. The exposed true umbilicus, the rather large false umbilicus, and the persistence of the beaded microscopic sculpturing on the first three

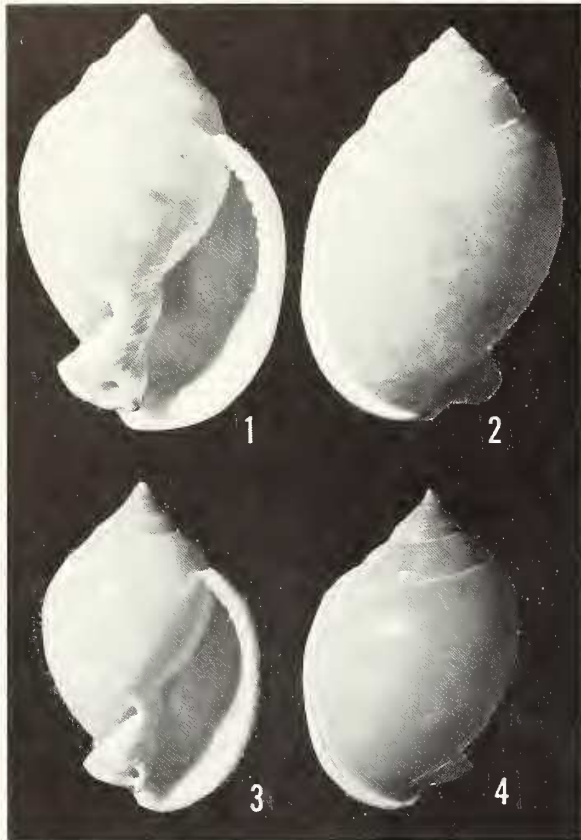


Plate 128. *Phalium* (*Semicassis*) *glabratum* subspecies *angasi* (Iredale, 1927). Figs. 1, 2, holotype of *angasi* Iredale, 52 mm. Figs. 3, 4, holotype of *knighti* (Thornley, 1954), 40.0 mm. (Both in the Australian Museum; photo courtesy of D. F. McMichael).

post-nuclear whorls readily distinguished it from typical *glabrata glabrata*. The surface of the body whorl is weakly malleated as in the Japanese subspecies *bullata*. *S. glabrata angasi* is moderately common in 10 to 20 fathoms off shore. The indented left edge of the columellar shield is present in two other distantly related Australian cassids which may be interpreted as a "regional" character.

Thornley's *knighti*, originally described as a subspecies of "*Xenogalea angasi*" is merely a minor variant, being pale pinkish, more rounded and less sculptured.

Description—Adult shell 33 to 58 mm. (about 1-1/4 to 2-1/4 inches) in length, thin-shelled, light in weight, but strong; elongated; glossy, with a slightly malleated surface, translucent white, tan or blotched with purplish tan; rarely with a few faint, small rectangular, brownish, subsutural blotches; with a deep, small true umbilicus and a false umbilicus of about the same size. Whorls 8. Nuclear whorls 3, bulimoid, glossy smooth and opaque-white. First 3 post-nuclear

whorls with 5 to 7 beaded spiral threads. In later whorls, the beading disappears, but 1 to 3 faint spiral lines may persist in the last whorl. Body whorl glistening and smoothish. There is a blush of mauve-tan on the dorsal side of the body and penultimate whorls. Aperture relatively narrow. Varix narrow, strong, slightly recurved to form a gutter behind, white to yellowish. Inner side of varix with about 15 to 18 small, moderately sharp prickles. Rarely with a former varix. Columellar shield poorly developed and with numerous, fine, spiral wrinkles. Left edge of columella strongly indented in the region of the true umbilicus. Interior of aperture white or light-tan. Base of shell with 3 to 5 weak, spiral, incised lines. Soft parts and operculum unknown.

Measurements (mm.)—

		no.	
length	width	whorls	
57.5	33.0	8	large; off Brunswick Heads, N.S.W.
52.0	33.1	7	holotype of <i>angasi</i> Iredale
40.0	25.0	6.5	holotype of <i>knighti</i> Thornley
38.0	24.0	6	holotype of <i>denisi</i> Salmon
33.1	20.7	7	small; off Darwin, N.W. Australia

Synonymy—

- 1911 *Cassidea angasi* Brazier, Shirley, Proc. Royal Soc. Queensland, vol. 23, p. 98 (Caloundra, Queensland). *Nomen nudum*. [not seen].
 1927 *Xenogalea angasi* Iredale, Records Australian Museum, vol. 15, p. 350, pl. 32, fig. 15 (Moreton Bay [Brisbane], Queensland [Australia]).
 1948 *Phalium denisi* Salmon, Jour. de Conchyl., Paris, vol. 88, p. 161, text figs. on p. 162 (no locality).
 1954 *Xenogalea angasi knighti* Thornley, Proc. Royal Zool. Soc. New South Wales for 1952-53, p. 33, pl. 1, fig. 6 (Sinclair Bay, Gloucester Id., near Bowen, Queensland, Australia).

Habitat—Thornley (1954, p. 33) reports that this subspecies burrows in 4 to 6 inches of sand on sandy flats exposed to strong tidal currents (near Bowen, Queensland). It also occurs at depths of 10 to 35 fathoms on sandy bottoms.

Types—The type locality of *angasi* given by Iredale is Moreton Bay, Brisbane, Queensland, Australia. The holotype is in the Australian Museum in Sydney, no. C 2485. The holotype of Thornley's *knighti* is also in the Sydney Museum, no. C 63955. The holotype of Salmon's *denisi* is in the Museum d'Histoire Naturelle in Paris.

Records—(all Australia). NORTHERN TERRITORY: Arafura Sea, off Darwin (A. R. Cahn, coll'n., ANSP); 15-20 fms., 100 mi. N.W. of Darwin (Vernon Wells, ANSP). QUEENSLAND: Cowlshaw Reef (B. Kaspiew, ANSP); Bowen, Cape Gloucester (Aust. Mus.); 20 fms., Keppel Bay (Tony Marsh, ANSP); 10 fms., Hervey Bay (Aust. Mus. and ANSP); 35 fms., Tin Can Bay, S.E. of Fraser Id. (T. A. Garrard, ANSP); Coloundra (ex Shirley, 1908, Nat. Mus. Vict.); Bowen (Nat. Mus. Vict.); Noosa Heads (B. Bardwell, Nat. Mus. Vict.). NEW

SOUTH WALES: Tweed Heads (J. Kerslake, ANSP); Ballina (Aust. Mus.); 12 fms., off Evans Head (T. Hartley, ANSP); 18 fms., off Brunswick Heads (H. Bienke, ANSP); off Macleay River (Aust. Mus.).

Fossil records—None reported.

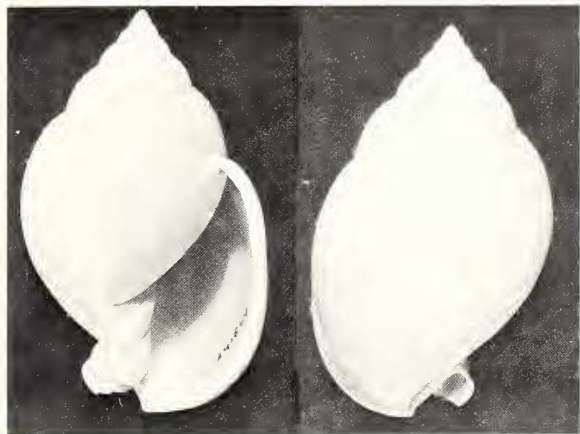


Plate 129. *Phalium (Semicassis) glabratum* subspecies *bullae* (Habe, 1961). Sagami Bay, Honshu, Japan. 53 mm.

***Phalium glabratum* subspecies
bullae (Habe, 1961)**

(Pl. 8, figs. 7, 8; pl. 129)

Range—Off the southern coasts of Japan to off southeast China; and Hawaii.

Remarks—The northern subspecies *glabratum bullae* Habe is not uncommonly trawled at depths of about 100 fathoms off the southeast coasts of southern Honshu and Shikoku Islands of Japan. The "Albatross" dredged a specimen in 88 fathoms, 200 miles southeast of Hong Kong, China, and it is probable that it occurs in the intervening areas. The shells are relatively fragile and translucent like those of the Australian subspecies, but differ in lacking the strong indentation of the left edge of the columellar shield and in having about two dozen, narrow, mauve streaks on the last varix. A former varix is sometimes present on the penultimate whorl.

The name "*Cassis tenuis* Hirase" used on labels by Japanese shell dealers is evidently a *nomen nudum*. Kuroda (Venus, vol. 17, no. 1, p. 35, 1952) in a footnote gave a brief descriptive key of Japanese cassids, without generic names, and introduced the names *obscurum* and *bullae*. Both names refer to the Japanese subspecies but are nomenclatorially invalid. The first validation of *bullae* occurs in Habe's 1961 "Coloured Illustrations of the Shells of Japan (II)".

Description—Adult shell 40 to 53 mm. (about 1½ to 2 inches) in length, similar to *glabratum angasi*, but with 12 to 25 fine, spiral, mauve stripes on the varix, with the left edge of the columellar shield only slightly sinuate (instead of well-indented), and with a proportionately smaller true and false umbilicus. Upper parietal wall in the posterior area of the aperture bears a clump of 3 to 5 very short, elongate, raised pustules, as in *angasi*. Operculum unknown.

Measurements (mm.)—

length	width	no. whorls	
53.1	32.6	8	large; Sagami Bay, Honshu Id.
48.2	28.0	8	off Tosa, Shikoku Id.
44.9	27.0	8	off Pratas Id., S.W. China Sea
39.2	24.6	8	small; off Tosa, Shikoku Id.

Synonymy—

1931 *Phalium (Bezoardica) tenuis* Hirase, Yokoyama, Cat. Marine, Freshwater and Land Shells of Japan, Imperial Geol. Survey Japan, Tokyo, p. 36 [*nomen nudum*]

[1952 *obscurum* and *bullae*, Kuroda, Venus, vol. 17, no. 1, p. 35, footnote; species names only; invalid].

1961 *Semicassis bullae* "Kuroda" Habe, Coloured Illustrations of the Shells of Japan, Osaka, vol. 2, p. 44, pl. 21, fig. 5 (Tosa, Japan, 50-100 fms.); 1961 Oyama, The Molluscan Shells, Resources Exploitation Institute, Tokyo, vol. 5, *Semicassis* plate 2, fig. 8 (Kumano-Nada).

1961 *Semicassis obscurum* "Kuroda" Habe, loc. cit., p. 44, pl. 21, fig. 6 (Japan, 50-100 fms.); 1961, Oyama, The Molluscan Shells, Resources Exploitation Institute, vol. 5, *Semicassis* plate 2, figs. 6, 7 (Tosa).

Types—The type locality is Tosa, Shikoku Id., Japan, 50-100 fms. I cannot locate the type of either *bullae* or *obscurum*.

Records—JAPAN: HONSHU: Sagami Bay; Ise Bay, Mieken. SHIKOKU: Tosa, 100 fms. (all A. R. Cahn coll'n., ANSP). CHINA: 200 mi. S.E. of Hong Kong, off Pratas Id., 88 fms., "Albatross" Sta. 5311 (USNM). HAWAIIAN IDS.: 100 to 200 fms., mud, off Waikiki, Oahu Id., Pele Expedition, 1963 and 1964 (BPBN); 30 fms., live, off Keehi Lagoon, Oahu Id., C. S. Weaver, Sept. 1959.

***Phalium semigranulosum* (Lamarck, 1822)**

(Pl. 8, figs. 1, 2; pls. 130-131)

Range—Tasmania and the southern coast of Australia.

Remarks—This is a common and well-known species of southern Australia which is characterized by the strongly beaded upper third of each whorl, by its chalky, whitish to pinkish coloration, and by its sealed false umbilicus. The parietal shield is very poorly developed and the

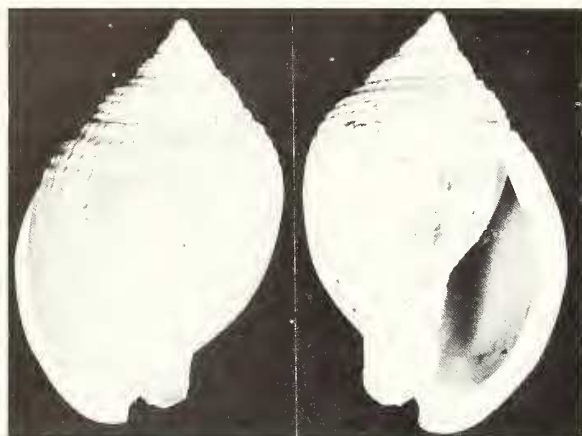


Plate 130. *Phalium* (*Semicassis*) *semigranulosum* (Lamarck, 1822). Holotype. 48 mm. in length. [South Australia]. Mus. Geneva.

columella weakly lirate only within the aperture. I consider *Antephalium* of dubious subgeneric value.

Habitat—Moderately common on sand bottoms from a foot below low tide to depths of 15 to 200 fathoms. "Located on sandbanks, the animals are extremely active, preying on bivalve molluscs; excellent living examples have been obtained during night collecting at Portsea, while cast-up specimens are not uncommon at many points on the Victorian coast." (MacPherson and Gabriel, 1962, p. 146).

Description—Adult shell 29 to 600 mm. (about 1-1/8 to 2-1/2 inches) in length, solid, somewhat elongated, beaded on the upper third of the whorls, with a sealed-over true umbilicus, without a false umbilicus, and colored a uniform pastel pinkish tan or cream white. Whorls 6 to 8. Nuclear whorls 2-1/2, bulimoid, smooth, opaque white, tan or purplish. Post-nuclear whorls with 5 or 6 spiral rows of fine, evenly-spaced, rounded beads located on the upper third of the whorls. One row of beads borders the suture below, and below that is a relatively wide, slightly concave, shallow gutter bearing only axial wrinkles or growth lines. Aperture relatively narrow, the interior light-tan to brownish. Parietal wall with a slight glaze covering a dozen, weak, spiral incised lines. At the upper end of the aperture the parietal wall bears 3 to 5 obliquely-placed, raised, smooth, whitish plicae which may be fused into a small mound. Columellar shield poorly developed, glossy-white, bearing about 9 short, spiral wrinkles within, and with its smooth, rounded left edge entirely or partially sealing the true umbilicus.

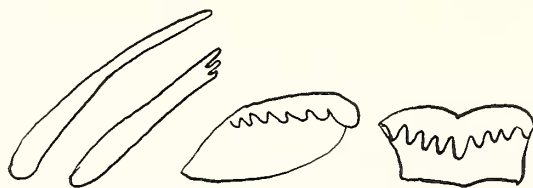


Plate 131. *Phalium semigranulosum* (Lamarck). Radula. Modified to a different view from Cotton, 1945, p. 169.

Former varices usually absent. Last varix narrow, strong, smooth, cream-colored, and slightly recurved. Base of shell with a dozen spiral threads or incised lines. Operculum corneous, elongate, fan-shaped, brownish and with weak growth lines. Rachidian with 10 cusps; lateral with 8, inner marginal with 4, outer marginal simple, according to Cotton, 1945, p. 169.

Measurements (mm.)—

length	width	no. whorls	
60.6	39.0	7	large; Portsea, Victoria
52.6	33.0	7	average; Hobart, Tasmania
48.0	30.9	7	Lamarck's holotype
29.0	18.0	6	small, Western Australia

Synonymy—

- 1822 *Cassis semigranosa* Lamarck, Anim. sans Vert., vol. 7, p. 228, no. 23 (Nouvelle-Hollande); 1824, Dubois, Epitome Lamarck's. . . Testacea, p. 253.
 1828 *Buccinum semigranulosum* Wood, Index Testaceologicus, Supplement, p. 11. pl. 4, fig. 2.
 1828 *Cassis semigranosa* Wood, loc. cit., p. 33, pl. 4, fig. 2.
 1840 *Cassidea semigranosa* Lamarck, Swainson, Treatise on Malacology, London, p. 299.
 1853 *Semicassis semigranosa* Lam., H. and A. Adams, Genera of Recent Mollusca, London, vol. 1, p. 216.
 1857 *Cassis semigranosa* Wood, Küster, Syst. Conchylien-Cabinet, ed. 2, vol. 3, pt. 1 b, p. 24, pl. 44, figs. 6, 7; 1885, Tryon, Manual of Conch., Phila., vol. 8, p. 275.
 1886 *Cassis semigranosa* Lam., Brazier, Trans. Royal Soc. South Australia for 1886, reprint p. 8 (long synonymy).
 1945 *Antephalium semigranulosum* (Lamarck), Cotton, Trans. Royal Soc. South Australia, vol. 69, no. 1, p. 169, text fig. of radula and operculum; 1962, MacPherson and Gabriel, Marine Molluscs of Victoria, Melbourne, p. 146, fig. 174.

Types—Lamarck's holotype is in the Lamarck collection in the Museum of Natural History of Geneva, Switzerland. The type locality is "Nouvelle-Hollande". We further restrict the type locality to Hobart, Tasmania.

Nomenclature—This is one of the few cassids described in the early nineteenth century which has no synonyms. As Brazier pointed out in 1886, both Küster and Tryon were in error in attributing the authorship of *semigranulosum* to Wood.



Plate 132. Geographical distribution of *Phalium (Semicassis) semigranosum* (Lamarek).

Records—(all Australia) TASMANIA: Hobart; Swansea; Stanley; 20 fms., in d'Entrecasteux Channel. T. A. Garrard; Frederick Henry Bay, G. Pridmore, 1967. (all ANSP); Bridport, Dorset (MCZ). VICTORIA: Portsea; Pewhaven; Western Port; Lake Entrance (all Nat. Mus. Vict.); Wilson's Promontory; San Remo, near Melbourne (both ANSP). SOUTH AUSTRALIA: Encounter Bay (ANSP); Middleton; Aldinga Bay (both Nat. Mus. Vict.); Port Willunga (MCZ); 15 fms., Yankalilla Bay; Pondolowie Bay; Lacepede Bay; 20 fms., Newland Head; off Beachport in 100, 110, 150 and 200 fms., 55 and 62 fms., off Cape Borda; 90 and 130 fms., off Cape Jaffa; 15 to 20 fms., off St. Francis Island (all B. C. Cotton, 1945, p. 169). WESTERN AUSTRALIA: Cheyene Beach, 50 mi. east of Albany (B. R. Wilson, West. Aust. Mus.); Leighton Beach (West. Aust. Mus.); 12 and 35 fms. in King George Sound; 35 fms., off Hopetown; Bunbury (B. C. Cotton, 1945, p. 169).

[records from New Zealand and South Africa are probably erroneous].

Fossil records—None reported.

***Phalium muelleri* (Tate, 1889)**

(Pl. 133)

Range—Pliocene of South Australia and Muddy Creek, Victoria, Australia.

Remarks—I am inclined to agree with Ludbrook (1958) that this species is close to *semigranosum*. The original description reads:

"Shell rather thin, globosely inflated; spire short, ending in a small pullus [nucleus] of one and a half, smooth, slightly swollen whorls.

"Whorls four, excepting pullus, separated by an impressed suture, roundly angled medially, spirally ribbed; the posterior whorls with about four spiral ribs, tessellated by transverse threads; penultimate whorl with a stout medial ridge, two behind, one at the posterior suture, and two or



Plate 133. *Phalium (Semicassis) muelleri* (Tate, 1889). Type from the Upper Beds at Muddy Creek, Victoria, Australia. Pliocene. Length: 25 mm.

three in front. The ribs are rounded, unequally disposed, incised by rather distant oblique threads.

"Last whorl ventricose, with a round shoulder, posterior to which are five spiral ribs, the medial one the strongest, the posterior one margining the suture; the ribs are crossed by sharp threads which crenulate them, but on the middle of the whorl are obsolete or continued as striae; base with a few encircling depressed ribs.

"Aperture ovately lunate; outer lip plain, reflected; columella nearly straight, medially thickened, twisted and obliquely truncated at the end, with about ten slender revolving plaits, expanded over the umbilical region. Length, 25; breadth, 20; length of aperture, 18."

Synonymy—

1889 *Semicassis muelleri* Tate, Trans. and Proc. Royal Soc. South Australia, vol. 11, p. 167, pl. 7, fig. 9 (Upper beds at Muddy Creek); 1896, Harris, Cat. Tertiary Mollusca, pt. 1, p. 199.

1943 *Antiphalium* [sic] *mulleri* (Tate), Crespín, Mineral Resources Survey Bull. 9, p. 95.

1958 *Semicassis (Antephalium) muelleri* Tate, Ludbrook, Transactions Royal Soc. South Australia, vol. 81, p. 52, pl. 2. (Kalinnan—Dry Creek Sands; Gippsland, Victoria; Adelaide, South Australia.

***Phalium adcocki* (Sowerby, 1896)**

(Pl. 134)

Range—Known only from the southern coast of Australia.

Remarks—This small but very attractive cassid has been collected on very few occasions. Less than a dozen specimens are known, one of these coming from a depth of 100 fathoms. Mr. George Pattison of South Australia has found them alive on reefs in St. Vincent Gulf. It is readily recognized by its solid shell, by the 6 spiral rows of very small, bright, red-brown spots on the body

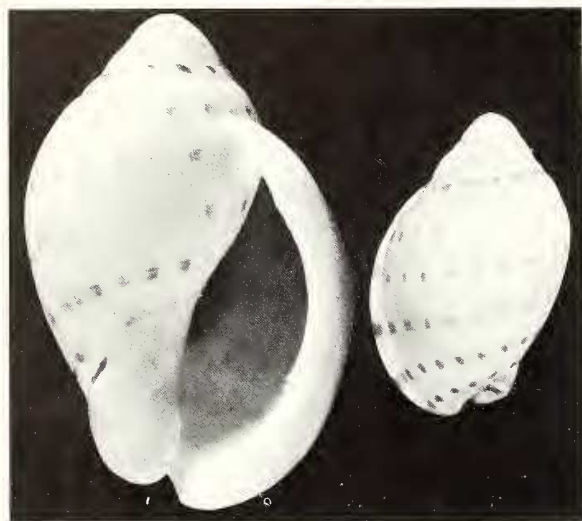


Plate 134. *Phalium (Semicassis) adcocki* (Sowerby, 1896). Yankalilla Bay, South Australia. A beach-worn specimen. American Museum Natural History no. 87744. 25.5 mm. in length.

whorl and by the axial, beaded plicae or wrinkles on the shoulders. The species shows no very close morphological relationships with other Australian cassids, although the Recent *semigranosum* (Lamarck) and the fossil *transennum* (Tate) have some features in common with it. Below, I am paraphrasing most of Iredale's excellent re-description:

Description—Adult shell 25 to 44 mm. (about 1 to 1¾ inches) in length, solid, regularly oval, white with 6 rows of very small spots of red-brown, and sculptured with strong axial plicae and weak spiral lines. Whorls 5; nuclear whorls white and smoothish. Adult whorls 3 to 4, the earlier ones spirally lirate and crossed by strong slanting axial threads or plicae which form a reticulation on the upper third of the whorls. Last whorl with 20 to 25 short axial, somewhat beaded plicae or wrinkles. Below are 18 to 20 spiral threads. Coloration pure-white, marked with spiral rows of small, bright red-brown spots, 6 rows on the body whorl, 20 spots to a row. Varix strong, smooth, white, with 5 spots, and weakly dentate at the anterior inner region. Parietal shield is merely a thin glaze. Columellar shield thick, rounded, sealing the umbilicus, and on the lower half with numerous, weak, spiral wrinkles. Siphonal canal short, tipped with red-brown, and bounded posteriorly by a narrow, rather deep gutter. False umbilicus absent.

Measurements (mm.)—

length	width	no. whorls	
28.0	17.0	6	holotype, fide Sowerby, 1896
25.5	17.0	5	Yankalilla Bay, S. Australia
24.6	16.5	6	South Australia; Nat. Mus. Vict.

Synonymy—

- 1896 *Cassis adcocki* Sowerby, Proc. Malacological Soc. London, vol. 2, p. 14, text fig. (Yankalilla Bay, South Australia); 1912, Gatliff and Gabriel, Proc. Royal Soc. Victoria, new series, vol. 25, p. 170.
 1912 *Cassidea adcocki* Sowerby, Verco, Trans. Royal Soc. South Australia, vol. 36, p. 217; 1916, Hedley, Jour. Royal Soc. Western Australia, vol. 1, p. 47.
 1927 *Antephalium adcocki* Sowerby III, Iredale, Records Australian Mus., vol. 15, p. 352; 1954, Cotton, Malacological Section, Royal Soc. South Australia, no. 4, p. 2, pl. 1, fig. 18; 1962, MacPherson and Gabriel, Marine Molluscs of Victoria, Melbourne, p. 147.

Types—The type locality is Yankalilla Bay, South Australia, Australia. I have been unable to find the type which may have been in Mr. D. J. Adcock's collection.

Records—(all Australia) VICTORIA: Bass Strait (Gatliff and Gabriel, 1912, p. 170). SOUTH AUSTRALIA: (Gatliff coll'n., Nat. Mus. Vict.); "The Gorge", Yankalilla Bay (R. F. Leane, Amer. Mus. Nat. Hist.); Marion Reef; Normanville Reef; Aldinga Beach; Kangaroo Id., Port Victoria (all George Pattison, *in litt.*). WESTERN AUSTRALIA: 90 miles west of Eucla, Great Australian Bight, 100 fms. (Verco, 1912, p. 217).

Fossil records—None reported.

Phalium sinuosum (Verco, 1904)

(Pl. 135)

Range—Off South Australia to Western Australia.

Remarks—This inch-long, moderately thin-shelled cassid somewhat resembles a dwarfed *P. bisulcatum* (Schubert and Wagner), but it is characterized by its more elongated shape, the pinched-in outer lip and the weak columellar shield. The color spots are fewer, larger and more subdued than those of *P. adcocki*. Verco in 1904, with a series of 22 individuals before him, recognized that this species varies considerably in shape and color pattern. He mentioned a color variety A which was slightly narrower and which had the spotting fused into wavy, axial bands. Cotton and Godfrey in 1931 gave this form the name *angustatum*, and in 1945 and 1954 Cotton maintained it as a full species. We believe, however, that this taxon is merely a *forma*, and is well within the varietal limits of the species.

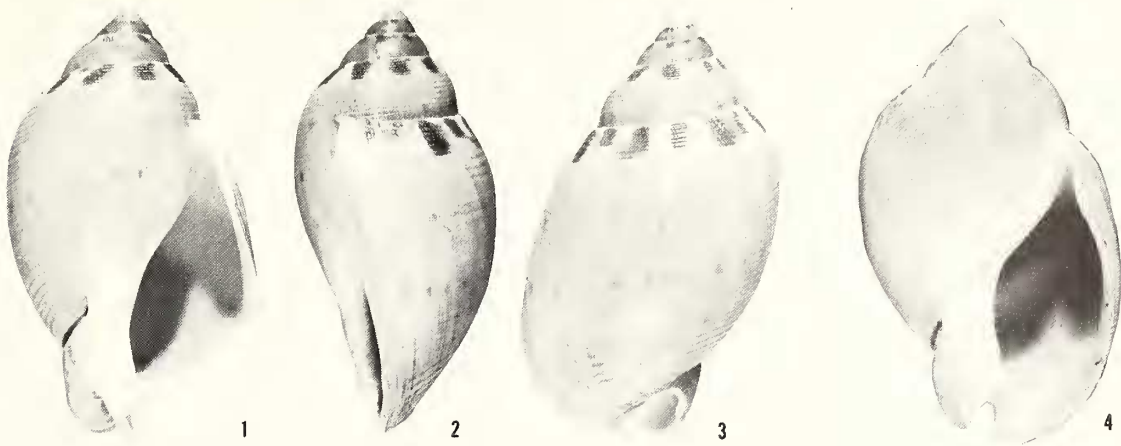


Plate 135. *Phalium (Semicassis) sinuosum* (Verco, 1904). Figs. 1-3, 10 fathoms off Binningup, 90 miles south of Fremantle, Western Australia. E. Nickels, collector, 1964. 27.1

The species is rare in collections, although Verco dredged 22 individuals in the Backstairs Passage of South Australia.

Description—Adult shell 17 to 27 mm. (about 1 inch) in length, thin-shelled, moderately strong, oval-elongate, microscopically and spirally striate, cream with sparse buff spotting or wavy bands. Whorls 5 to 6. Nuclear whorls 2, bulboid, smooth, opaque-white. Post-nuclear whorls with 10 to 13 microscopic threads which are crossed by fine, axial growth lines. On the body whorl the threads become flattened, especially on the middle of the whorl. Suture fine and bordered below by a finely beaded thread. Aperture constricted at the posterior third by the in-turning of the slightly thickened outer lip. Varix minute. Inside of outer lip weakly dentate. Parietal shield merely a weak glaze. Columellar shield white, poorly developed and with about a dozen fine, spiral wrinkles. True umbilicus almost completely sealed. False umbilicus at the base of the columella is small, deep and slit-like. Siphonal canal short. Color of shell cream to whitish with 5 spiral rows of subdued, squarish, relatively large brownish yellow spots which, in some specimens, may be elongated and merged to form oblique axial flames or bars. In some specimens, color blotches are limited to a series just below the suture. In living specimens the background tint of the shell is light pinkish brown, deeper on the nucleus and early post-nuclear whorls. Spots in spiral rows vary from 7 to 15 per whorl. Siphonal gutter narrow and shallow.

mm. Fig. 4, holotype of *Cassidaria sinuosa* Verco, 1904. Investigator Strait, South Australia. South Australian Museum. 24.6 mm.

“Radula with a rachidian with 6 small cusps on each side of a large central cusp; lateral tooth with 13 cusps; marginals long, slender and simple”. (Verco, 1904).

Measurements (mm.)—

length	width	no. whorls	
27.5	—	—	largest, fide Verco, 1904
27.2	15.0	6.0	Western Australia
24.6	15.5	6.0	holotype, D.13477, of <i>sinuosa</i> Verco
19.6	11.4	5.0	holotype of <i>angustatum</i> C. and G.
19	11	—	paratype, fide Verco, 1904
17.2	11.9	5	South Australia; Nat. Mus. Vict.

Synonymy—

- 1904 *Cassidea sinuosa* Verco, Trans. and Proc. Royal Soc. South Australia, vol. 28, p. 141, pl. 26, figs. 7-10, a-c (Investigator Strait, Backstairs Passage, South Australia).
- 1922 *Phalium sinuosum* Verco, Gatliff and Gabriel, Proc. Royal Soc. Victoria, new series, vol. 34, p. 143 (May, 1922).
- 1927 *Antecephalum sinuosum* (Verco), Iredale, Records Australian Museum, vol. 15, p. 353; 1931, Cotton and Godfrey, South Australian Naturalist, vol. 13, no. 1, p. 17; 1954, Cotton, Mal. Sect., Royal Soc. South Australia, no. 4, p. 2, fig. 19; 1962, MacPherson and Gabriel, Marine Molluscs of Victoria, Melbourne, p. 147.
- 1931 *Antecephalum sinuosum angustatum* Cotton and Godfrey, South Australian Naturalist, vol. 13, no. 1, p. 17, pl. 2, fig. 5 (Backstairs Passage, 20 fms.).
- 1945 *Antecephalum angustatum* Cott. and Godf., Cotton, Trans. Royal Soc. South Australia, vol. 69, p. 251; 1954, Cotton, Mal. Sect., Royal Soc. South Australia, no. 4, p. 2, fig. 20.

Types—The type locality for *sinuosa* is “dredged in Investigator Strait, Backstairs Pas-

sage." The type is in the South Australian Museum, no. D.13477. The type locality for *angustatum* is also "Backstairs Passage", in 20 fathoms. The holotype is in the South Australian Museum no. D 10171, and was kindly loaned to me for photographing.

Records—(all Australia). VICTORIA: "taken off cable to

Tasmania, Bass Strait" (Gatliff and Gabriel, 1922, p. 143); 20-25 fms., off Lakes Entrance (Macpherson and Gabriel, 1962, p. 147). SOUTH AUSTRALIA: 40 fms., off Willoughley, Kangaroo Id., 1928 (George Pattison, *in litt.*, 1962); off Point Marsden, Kangaroo Id. in 15, 16, 17, 19 and 20 fms. (Verco, 1904, p. 141); Backstairs Passage (Verco, 1904, p. 141 and Cotton and Godfrey, 1931, p. 17); (Nat. Mus. Vict., Gatliff coll'n.); Beachport (Cotton and Godfrey, 1931, p. 17). WESTERN AUSTRALIA: 10-12 fms., 1 mile offshore, Binningup, 90 miles south of Fremantle (E. Nickels, coll.).

Fossil records—None reported.

[These occasional blank areas occur between genera and subgenera to permit the insertion of new material and future sections in their proper systematic sequence.]

Phalium saburon (Bruguère, 1792)

(Pl. 12, figs. 16-19; pls. 136-138)

Range—Mediterranean and northward to the Bay of Biscayne, France, and southward to Accra, Ghana, Africa; Azores.

Remarks—This moderately common Eastern Pacific species is characterized by its rather thick shell, globular shape, and by the numerous, fine, incised spiral lines on the body whorl. The columellar shield is mostly smooth, except for a few irregular, short lirae on the lower inner area. The columella bears from 5 to 8 irregularly-sized spiral plicae. Unlike the other Mediterranean cassid, *undulatum* Gmelin, *saburon* has a closed false umbilicus. The color of the shell is whitish with five diffused spiral bands or rows of yellowish brown spots. In some localities the shells may become covered with a dark black-brown stain. In length, the shell varies from 40 to 60 mm. (about 1-1/2 to 2-3/4 inches). The fan-shaped operculum is brown, with fine concentric growth lines and feeble, wide radial rays.

This species and its fossil progenitors have been on the south European scene since the Miocene. *P. craticulatum* (Euthyme, 1885) [*africanum* Fulton, 1930] is probably a remnant which is now isolated in South Africa. Records for *saburon* in the early literature referring to the Indo-Pacific were doubtlessly based upon specimens of *bisulcatum* (Schubert and Wagner).

Phalium (*Semicassis*) *saburon* and its fossil forms have been reported throughout Europe from the Miocene, Pliocene and Pleistocene. Its range in the Miocene extended from Belgium and the Netherlands to Poland and Austria. It is known from the Pliocene of England, France

and Italy, but evidently its range has somewhat shrunk in the Recent. There is a natural difficulty in distinguishing fossil *saburon* specimens from those of *laevigatum* Defrance, since the latter doubtlessly gave rise to the Recent *saburon*.

Synonymy—

1792 *Cassidea saburon* Bruguère, Encyclopédie Méthodique (Vers), vol. 1, pt. 2, p. 420, no. 4 (l'isle de Gorée; Méditerranée; Lisbonne). Refers to several figures, Adanson, pl. 7, fig. 8; Gualtieri, pl. 39, fig. G, and others.

1793 *Buccinum arcata* [sic] Linn., von Salis, Reisen. . . . Neapel, Zurich, vol. 1, p. 367, no. 37 (Naples); 1795, *ibid.*, London edition, p. 458, no. 37.

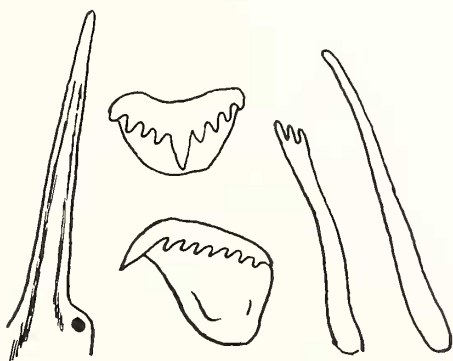


Plate 136. *Phalium* (*Semicassis*) *saburon* (Bruguère). Right tentacle and radula of a female from St. Jean de Luz, Biarritz, France.



Plate 137. *Phalium* (*Semicassis*) *saburon* (Bruguère, 1792). Figs. 1, 2, heavy form from St. Jean de Luz, Biarritz, France, 67.4 mm. Figs. 3, 4, elongate and light-weight form from Pointe-Noire, Republic of Congo, 51.9 mm. Figs. 5, 6, ovate and light-weight form, Caparica Beach, near Lisbon, Portugal, 55.5 mm.

- 1822 *Cassis saburon* Brug., Lamarck, Anim. sans Vert., Paris, vol. 7, no. 227; 1882, Bucquoy, Dautzenberg and Dollfus, Moll. Roussillon, vol. 1, p. 64, pl. 7, figs. 1, 2; 1868, Weinkauff, Conchylien de Mittelmeeres, Cassel, vol. 2, p. 39.
- 1829 *Cassis pomum* Schubert and Wagner, Conchyl.-Cabinet, Nurnberg, vol. 12, p. 71, figs. 3084, 3085 (no locality).
- 1857 *Cassis nucleus* Küster, Martini-Chemnitz, Syst. Conch. Cab., vol. 3, pt. 1, pl. 52, fig. 3, 4.
- 1870 *Cassis (Cassidea) saburon* Bruguière, Hidalgo, Moluscos Marinos Espana. . . , vol. 2, Cassis, p. 6, pl. 3, figs. 2, 3.
- 1878 *Cassis saburon* var. *abbreviata* Monterosato, 1878, Enum. e Sinon. Conch. Medit., p. 42.
- 1882 *Cassis saburon* var. *varicosa* "Philippi", Bucquoy, Dautzenberg, and Dollfus, Moll. Marins Roussillon, vol. 1, p. 65 (refers to Kiener, 1835, pl. 14, fig. 27).
- 1886 *Cassis saburonii* Locard, Prodrôme Malac. Française, Moll. Marins, p. 147 (footnote) and p. 556. Emendation of *saburon* Brug.
- 1886 *Cassis adansonii* Locard, *ibid.*, pp. 148; 556 (Cape Breton; Roussillon; Cette).
- 1913 *Cassis saburon* var. *platystoma* "Brignone" Gignoux, Annales de L'Université de Lyon, new ser., fasc. 36, pt. 5, p. 529, pl. 15, fig. 1, 1 a (Quart.; Sicily).
- 1900 *Cassis (Semicassis) saburon* Brug., var. *minor*, *crassa* and *ex-colore* Pallary, Jour. de Conchyl., vol. 48, p. 298 (Oran).
- 1909 *Cassis saburon* Brug., var. *costulata* and *nigra* Argüelles, Boletín Sociedad Aragonesa Ciencias Naturales, Zaragoza, vol. 8, no. 2, pp. 43, 44.
- 1935 *Phalium (Semicassis) saburon* (Bruguière), Bayer, Zoolog. Mededeel., Leiden, vol. 18, p. 105.
- 1935 *Phalium saburon* var. *monterosatoi* Bayer, *ibid.*, p. 105. New name for *abbreviata* Monterosato, 1878, non Lamarck, 1822.
- 1962 *Cassis saburonii* Bruguière, Pasteur-Humbert, Travaux L'Inst. Sci. Chénifien, ser. Zool. no. 23, p. 68, fig. 99 (Maroc).

Types—The type locality is Sénégal, West Africa. According to E. Fischer-Piette the type, once belonging to Adanson, is now safely housed in the Muséum d'Histoire Naturelle in Paris. It is well-illustrated in the Journal de Conchyliologie, vol. 85, pl. 5, figs. 6a, 6b. Its length is 37.5 mm.; width; 27.5 mm. Our specimen on plate 6, fig. 18, closely resembles the type. The type of *pomum* Schubert and Wagner is in the Zoological Museum in Copenhagen.

Records—(Mediterranean). SYRIA: (Weinkauff, 1868, p. 40). TURKEY: Izmir (Smyrna) (Weinkauff, 1868, p. 40). GREECE: (Conemenos, ANSP). ITALY: Tarento; Sicily; Sardinia (Weinkauff, 1868, p. 40); Naples (USNM). SPAIN: Valencia (MCZ); PORTUGAL: common offshore along the west and south coasts (A. Nobre, 1932, p. 125, pl. 20); Caparica Beach, 5 miles south of Lisbon (P. Delpout, ANSP). ALGERIA: Algiers (USNM); Cape Falcon, near Oran (MCZ). MOROCCO: Méllilla (Cayetano, ANSP); Agadir (Franz Steiner, ANSP). FRANCE: Bay of Biscaye; mouth of the Gironde River (MCZ); d'Arcachon, 40-70 fms. (Mus. Roy. Hist. Nat. Belg.; MCZ). AZORES: Pico; San Miguel (both Mus. Roy. Hist. Nat. Belg.). SENEGAL: (Adanson, 1757). GHANA: Accra (Buchanan, 1954, Jour. West African Sci. Assoc., vol. 1, no. 1, p. 36).



Plate 138. Operculum of *Phalium (Semicassis) saburon* (Bruguière). Biarritz, France. Shell, 67.5 mm.; operculum, 24 mm.

European Tertiary *Phalium*

A host of forms belonging to this genus occurs in the Tertiary of Europe. There appear to be four general types, one leading to the Recent *saburon*, another to the *Phalium (Tylocassis) granulatum* complex, and a third which may be associated with the South African-Australian *pyrum* group. The fourth fossil, *striatellum* Grateloup from the Oligocene, may have given rise to the present-day *Semicassis* of the Indo-Pacific. No attempt is made to review these forms, but we are listing them below. I place all of them in the genus *Phalium*.

Cassis laevigata Defrance, 1817, Dictionnaires Sci. Nat., vol. 7, p. 210; Sacco, 1890, I Moll. Terr. Terz. Piemonte, pt. 7, pl. 1, figs. 30-35 (with new form names; *pliosulcatissima*, *pliodentata*, *plioasulcata*, *pliomalleata*, *plioinflata*, *plioigigantea*, *depressa*, *pliogloboides*, *pliodepressa*, *magnodentata*, *malleata*, *plio-crassa*, *pliolonga*, *additamentata*, *pluripliocata*, all Sacco); 1907, Sacco, Palaeontologia Universalis, p. 137, cotypes fig'd. *Cassis striata* Defrance, 1817, is a synonym (non J. Sowerby, 1812). Pliocene of Italy. Ruggier (1965, p. 150, Geol. Soc. Amer. special paper 84) believes *platystoma* "Bruguière" Gignoux, 1913, to be a synonym.

Semicassis miolaevigata Sacco, 1890, I Molluschi dei Terreni Terziarii Piemonte, pt. 7, p. 26, pl. 1, figs. 23-29 (with new form names: *miostrata*, *binisulcata*, *granulosa*, *rotunda*, *ovata*, *raristriata*, *miogloboides*, *tuberculata*, *depressa*, *laticauda*, *bidepressa*, *crassa*, *alata*, *limneoides*, *buccinoides*, *canaliculata*, *eden-tata*, *rotundo-varicosa*, *mioblonga*, *transiens*, *ornata*, *taurinensis*, all Sacco, 1890); 1924,



Plate 139. *Phalium* (*Semicassis*) *laevigatum* (Defrance, 1817). Tertiary of Italy. Holotype in Caen Museum. 54 mm.

Cossmann and Peyrot, Actes Soc. Linn. Bordeaux, vol. 75, p. 76, pl. 12, figs. 14-15. Miocene of Italy. See also Glibert, 1952, Inst. Royal Sci. Nat. Belgique, Mém. 121, p. 83, pl. 6, fig. 12.

Cassis dewalquei von Koenen, 1872, Schriften Gesell. Beförd. gesamt. Nat. Marburg, vol. 10, abh. 3, pt. 1, p. 206, pl. 1, fig. 7. A synonym of *bicoronatum* Beyrich, 1854, fide Glibert, 1952, p. 86, pl. 7, fig. 2 b, c.

Cassis hennei "Nyst" Dewalque, 1868, Prodrôme d'une descript. géolog. Belgique, Bruxelles, p. 421, Nude name, fide Glibert, 1952, p. 85.

Cassis subsulcosa Hoernes and Auinger, 1884, Die Gastropoden der Meeres-Ablagerungen der ersten und zweiten Miocänen Mediterran-Stufe, Vienna, p. 156; 1890, Sacco, var. *pedemontana* and subvar. *glabra* Sacco, I Moll. Terr. Terz. Piemonte, pt. 7, p. 38, pl. 1, fig. 38; 1952, Glibert, Inst. Royal Sci. Nat. Belgique, Mémoire no. 121, p. 85, pl. 6, fig. 13. Miocene. Anversien. Close to *Tylocassis*.

Cassis reticulata "Bonelli", Bellardi and Micheli, 1841, Memorie della Accademia di Torino, ser. 2, vol. 3, p. 145 (Colledi Torino, Italian Miocene). Bonelli's name is manuscript. A finely reticulate species; 1890, Sacco, I. Moll. Terr. Terz. Piemonte, pt. 7, p. 37, pl. 1, fig. 36 (with subvars. *rugulosa* and *globosa* Sacco).

Cassis neumayri R. Hoernes, 1875, Die Fauna des Schliers von Ottnang, p. 18, pl. 11, figs. 11, 12 (Miocene of Ottnang); 1884, R. Hoernes

and Auinger, Abhandlungen K. K. Geol. Reichsanstalt, vol. 12, pt. 4, p. 156, pl. 17, figs. 11, 12. Close to *reticulata* Bellardi and Micheli, 1841.

Cassis hoernes Sacco, 1890, I Molluschi dei Terreni Terziarii Piemonte, pt. 7, p. 50, pl. 1, fig. 51 (with subvar. *tuberculosa* Sacco, 1890). Miocene of Italy. An *Echinophoria*, fide Sacco.

Cassis striatella Grateloup, 1827, Bull. d'Hist. Nat. Soc. Linnéenne de Bordeaux, vol. 2, pt. 7, p. 20, no. 22 (St. Hean de Marsac, Dax, France); 1840, Atlas, pl. 34, fig. 15; 1924, Cossmann and Peyrot, Actes Soc. Linn. Bordeaux, vol. 75, p. 82, pl. 11, fig. 24-25.

Cassis grateloupi Deshayes, 1850, Traité élémentaire Conch., Paris, explanation to Atlas, p. 69, pl. 116, fig. 2 (no locality); 1924, Cossmann and Peyrot, Actes Soc. Linn. Bordeaux, vol. 75, p. 78, pl. 11, figs. 34-35 (with new forms: *varicigera*, *sacyi*, *cestasensis*, all Coss. and Peyr., 1924). Lower Miocene, France. Rather close to *miolaevigata* Sacco, 1890.

Cassis texta Bronn, 1827, Zeitschrift für mineralogie [= Taschenbuch für die gesammte mineralogie], vol. 2, p. 532. Not seen. Synonym of *laevigata* Defrance, 1817, fide Sacco, 1890, pt. 7, p. 32. Close to the *saburon* group.

Cassis subgranulosa Orbigny, 1852, Prodrôme de Paleontologie Strat. Universelle, Paris, vol. 3, p. 90, no. 1675. Synonym of *grateloupi* Deshayes, 1850, fide Cossmann and Peyrot, 1924, p. 78.

Cassis incrassata Grateloup, 1834, Actes Soc. Linn. Bordeaux, vol. 6, pt. 35, p. 202; 1840, Atlas, pl. 34, fig. 14 (1). Close to *laevigata* Defrance and *texta* Bronn; 1924, Cossmann



Plate 140. *Phalium* (*Semicassis*) *bicoronatum* (Beyrich, 1854). Miocene of Belgium. 39 mm. (from Glibert, 1952, pl. 7, fig. 2).

and Peyrot, Actes Soc. Linn. Bordeaux, vol. 75, p. 72, pl. 12, figs. 2-3. Miocene.

Semicassis dumasi Cossmann and Peyrot, 1924, Actes Soc. Linn. Bordeaux, vol. 75, p. 74, pl. 11, figs. 42, 43 (Saint-Jean-de-Marsac; Tortonien. Miocene). Close to, if not, *grateloupi* Deshayes, 1850.

Buccinum diadema Brocchi, 1814, Conchiologia fossile subapennina, vol. 2, p. 326, pl. 4, fig. 13 a, b (Piacentino). Undetermined; an immature form with a squarish, coronate, beaded shoulder.

Cassis bicoronatum Beyrich, 1854, Die Conchylien norddeutschen Tertiärgebirges, Berlin, vol. 1, p. 156, no. 6, pl. 9, fig. 4; 1952, Glibert, Institut Royal Sci. Nat. Belgique, Mémoires no. 121, p. 86, pl. 7, fig. 2. Approaching *Tylocassis*. [see pl. 138].

Cassis adami Eichwald, 1830, Naturhistorische

Skizze von Lithauen, Vollanden und Podolien, Wilna, p. 222 (Shukowze and Salisze); 1853, Lethaea Rossica, Stuttgart, vol. 3, p. 173, pl. 7, figs. 24, 25. A fossil form of *saburon*.

Cassis deucalionis Eichwald, 1830, Naturhistorische Skizze von Lithauen, Vollanden und Podolien, Wilna, p. 222 (Shukowze und Salisze); 1853, Eichwald, Lethaea Rossica, Stuttgart, vol. 3, p. 173, pl. 7, fig. 24 a, b. A fossil form of *saburon*.

Cassis diluvii de Serres, 1829. Geogn. Terr. Tert., p. 120. Probably a form of *laevigata* Defrance, 1817.

Cassis affinis Philippi, 1847, Palaeontographica, Cassel, vol. 1, pt. 2, p. 76, no. 159, pl. 10, fig. 11 (Osterweddingen); A fossil form of *saburon*. Philippi 1845, p. 450, is a nude name.

Cassis inflata de Serres, 1829, Geogn. Terr. Tert., p. 120. Probably *Phalium laevigatum* Defrance, 1817, or *saburon* Bruguière.

Cassis striata Defrance, 1817, Dictionnaire Sciences Natur., vol. 7, p. 209 (Plaisantin, Italy). A form of *laevigata* Defrance, fide Sacco, 1890, pt. 7, p. 33. Non *striata* Hutton, 1873, which is now *multisecta* Finlay, 1924. Non *striata* Grateloup, 1838, which is *Sconsia striata* Lamarck.

Cassis subareola Orbigny, 1852, Prodrome de Paléontologie Stratigraph. Universelle. Moll., Paris, vol. 3, p. 89, no. 1664. Refers to Grateloup, 1847, Conchyl. Fossile. . . . l'Adour, suppl. pl. 1, fig. 9, which resembles a *Xenophalium*.

Phalium craticulatum (Euthyme, 1885)

(Pl. 141)

Range—Off Cape and Natal Provinces, South Africa, to southern Mozambique.

Remarks—This uncommon mollusk was originally described by Euthyme in 1885 and later, in 1930, by H. C. Fulton as *africana*. It is closely related to *saburon* (Bruguère) of the Mediterranean and northwest Africa, but differs in being peculiarly pinched or narrowed toward the anterior end of the shell, and in having a strong, raised, toothed, axial ridge on the inner columella. The shell is very variable. Some are small (31 mm.), very thick-shelled and with strong, crowded, irregular, spiral threads, while others are large (80 mm.), light in weight, and smooth on the middle of the body whorl. Intergrades exist. The species has been trawled in several to 180 fathoms.

Phalium (Semicassis) microstoma (von Martens, 1901) from deep water off Somalia is closely related, but in the absence of more material, we have kept it as a separate species. *S. microstoma* is more evenly ovate in shape, with evenly-sized spiral cords, and with a considerably rugose columellar shield. It may subsequently prove to be a subspecies of *craticulatum*.

Description—Adult shell 31 to 80 mm. (about 1-1/4 to 3-1/4 inches) in length, solid or somewhat fragile, ovate in shape, but narrowing anteriorly; usually spirally threaded; whitish to gray in color, with or without subdued, irregular brown-

ish red spots; and with a coarsely-toothed ridge on the inner part of the columella. Nuclear whorls 3-1/2, bulimoid, white, and smooth. Post-nuclear whorls with numerous, crowded, irregularly-sized, spiral threads which may be crossed by weak growth lines. Body whorl with 40 to 50 spiral threads which are crossed by numerous microscopic scratches giving the surface a silky sheen under high magnification. True umbilicus very small or sometimes closed. False umbilicus usually only an indentation. Parietal shield slightly glazed. Columellar shield usually smooth, except for 1 to 5 small knobs at the base. Inner columellar edge with a strong whitish ridge bearing 8 to 11 coarse teeth, the lowest often separated by a gap from the series above. Inner edge of the reflected, thickened, glossy outer lip bears about a dozen irregularly-sized teeth which are strongest below. Inside of aperture white to light-brown. Color of shell whitish to cream (sometimes artificially stained with dark red-brown) and sometimes with 5 spiral rows of weak, small red-brown blotches. Operculum horny, smoothish and very thin.

Measurements (mm.)—

length	width	no. whorls	
80.5	51.4	7+	large; St. Francis Bay
64.2	43.0	9	large; St. Francis Bay
53.0	35.2	8	Durban, Natal
45.7	31.5	6+	Durban, Natal
42.1	28.1	8	holotype of <i>africana</i> Fulton
30.6	20.8	7	small; Durban

Synonymy—

1885 *Cassis craticulatus* Euthyme, Bull. Soc. Malacologique de France, Paris, vol. 2, no. 2, pp. 250-252 (St. Elizabeth, Cape Town).



Plate 141. *Phalium (Semicassis) craticulatum* (Euthyme, 1885). Figs. 1, 2, holotype of *Cassis africana* Fulton, 1930, off Natal, South Africa, in British Museum (Natural History)

no. 19317241. 42.1 mm. Figs. 3, 4, St. Francis Bay, South Africa. 80.5 mm. Figs. 5, 6, St. Francis Bay, South Africa. 64.1 mm. (courtesy of D. H. Kennelly).

- 1930 *Cassis africana* Fulton, Annals and Mag. Nat. Hist., series 10, vol. 6, p. 686, pl. 18, fig. 3 (off Natal, South Africa).
1935 *Phalium pila* var. *craticulata* (Euthyme), Bayer, Zoolog. Mededeel., vol. 18, p. 105.
1935 *Phalium* (*Semicassis*) *africanum* Fulton, Bayer, *ibid.*, p. 101.

Types—I was unable to locate Euthyme's type of *craticulatum*. It is not in the Musée d'Histoire Naturelle or the collections of the Ecole Nationale Supérieure des Mines in Paris. The type locality is Port Elizabeth, Cape Prov-

ince, South Africa. Fulton's holotype of *Cassis africana* is in the British Museum (Natural History) in London (Reg. no. 1931.7.24.1).

Records—SOUTH AFRICA: Port Elizabeth (Euthyme, 1885, p. 252); trawled in 60 fathoms, St. Francis Bay, off Elands River, Cape Province; trawled in shallow water, Durban, Natal (Helen Boswell, 1962, ANSP); 30 mi. east of Durban, Natal, 450 meters, sandy mud with stones; Galathea Station 196, Feb. 13, 1951 (Zool. Mus. Copenhagen). MOZAMBIQUE: 175 mi. ENE of Lourenço Marques, 525 meters; Galathea Station 202, Feb. 21, 1951 (Zool. Mus. Copenhagen).

Subgenus *Tylocassis* Woodring, 1928

Type: *Phalium granulatum* (Born, 1778)

This subgenus differs from *Semicassis* solely in having small, round, raised pustules, rather than spiral wrinkles, on the columellar shield. This difference is probably not very significant. Members of this group are limited to the Atlantic Ocean.

Synonymy—

1928 *Tylocassis* Woodring, Carnegie Inst. Washington, publ. no. 385, p. 306. (type by original designation: *Buccinum inflatum* Shaw, 1811 = *Phalium granulatum* (Born, 1778).

Phalium granulatum (Born, 1778)

The treatment of this species in this monograph differs from previous interpretations. Formerly, several species have been recognized from the Mediterranean, Caribbean and Pacific side of Central America. I believe this complex should be treated as a polytypic species of fairly long geologic standing and containing three geographically isolated subspecies. Although some workers have remarked upon the great similarity of these taxa, traditional literature



Plate 142. Section through the shell of *Phalium* (*Tylocassis*) *granulatum* (Born). The section shows the true and the false umbilicus at the base of the shell. (courtesy of Junius Sessoms).

and provincial faunistic studies have kept these "species" separate. Although some few specimens from these three geographical areas are morphologically very similar, the majority of colonies in each area show a common and peculiar range of variation. Below is a synopsis of the three Recent subspecies giving the characteristic features most common to each.

P. granulatum granulatum (Born, 1778)—Tropical Western Atlantic. Inner and center edge of columella slightly swollen; body whorl generally with 20 or 21 weak or strong spiral cords; brown spiral lines and long axial brown flames absent; pustules on columellar shield more numerous and finer than in *undulatum*; spire moderately produced. Operculum with weak radial ridges.

P. granulatum undulatum (Gmelin, 1791)—Mediterranean, Azores to Canary Islands. Inner and center edge of columella straight or slightly concave; body whorl generally with 17 or 18 strong spiral cords, between which are fine, brown lines; axial flames usually present; pustules on columellar shield proportionately larger and fewer than those in other subspecies; spire usually well produced. Operculum with strong radial ridges.

P. granulatum centiquadratum (Valenciennes, 1832)—Tropical Eastern Pacific from Mexico to Peru. Inner and center edge of columella slightly swollen; body whorl with about 20 to 22 low, flattish spiral cords with one or two at the shoulder being more prominent and generally bearing small knobs; brown spiral lines and axial flames absent; pustules on columellar shield about the same as those in *granulatum*; spire usually quite low. Operculum with obsolete radial ridges.

Phalium granulatum subspecies *granulatum* (Born, 1778)

(Pl. 12, figs. 1-7; pl. 145-147)

Range—Caribbean province from North Carolina, and Bermuda, to Bahia, Brazil.

Remarks—I am combining what has been heretofore considered two species by synonymizing *cicatricosum* (Gmelin, 1791) with the earlier *granulatum* (Born, 1778). These forms have been separated on sculptural differences. The very well corded and sometimes beaded form, *granulatum*, is dominant from North Carolina to Mexico and Costa Rica, although unmistakable examples occur sporadically in the Ba-

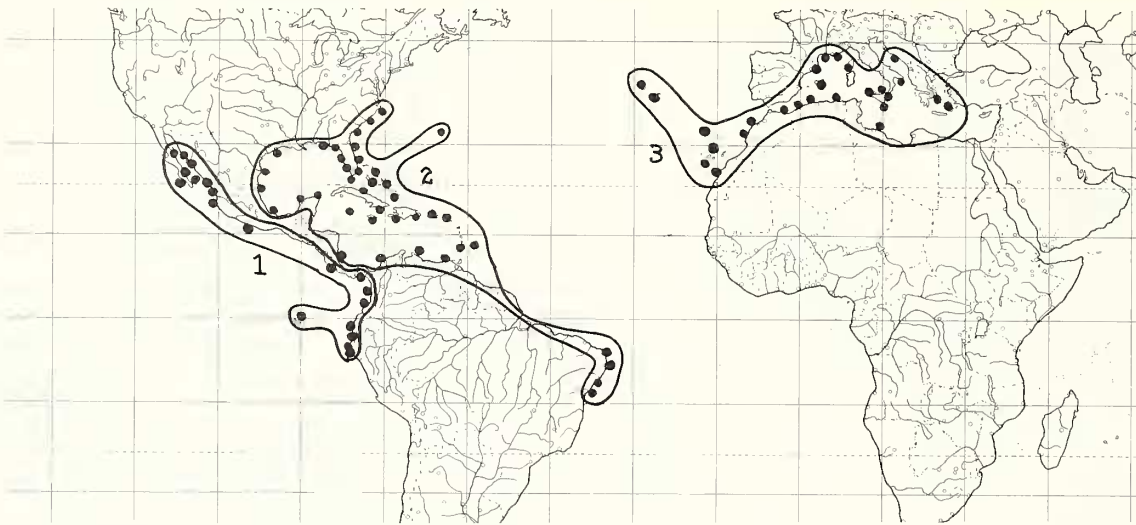


Plate 143. Geographical distribution of the subspecies of *Phalium* (*Tylocassis*) *granulatum* (Born). 1, *centiquadratum* (Valenciennes); 2, *granulatum* (Born); 3, *undulatum* (Gmelin).

hamas, Santo Domingo, Puerto Rico, Venezuela and Colombia. The smooth form, *cicatricosum*, is dominant in the West Indies and south to Brazil, although intergrades exist with the granulate form. Brazilian specimens are commonly over 90 mm. (3-1/2 inches) in length. In Florida, the smoother phase is expressed as an intergrade with a knobbed shoulder, a form named *peristephes* Pilsbry and McGinty, 1939. This variability within the species is also typical of the closely related *undulatum* (Gmelin, 1791) of the Mediterranean and *centiquadratum* (Valenciennes, 1832) of the Panamic Province. Colonies of extreme forms, having within themselves a great degree of uniformity, are responsible for the naming of these forms and their acceptance as different species. If it were not for the fact that *granulatum* forms and their intermediates existed throughout the entire range of the species, I would accept *cicatricosum* as a subspecies.

Clench (1944, *Johnsonia*, vol. 1, no. 16, pp. 6-10) deals with this complex and gives the full bibliographic listings of the synonyms which are: *Buccinum granulatum* Born, 1780; *Buccinum gibbum* Gmelin, 1791; *Cassidea granulosa* Bruguière, 1792; *Cassis malum* Röding, 1798; *Cassis cepa* Röding, 1798 (*Cassis sepa* Röding, Clench, 1944); *Cassis globulus* Röding, 1798; *Cassis minuta* Menke, 1829; *Buccinum inflatum* Shaw, 1811; *Cassis abbreviata* Lamarck, 1822; *Cassis laevigata* Menke, 1828 and 1830; *Cassis tessellata* Pfeiffer, 1840; *Cassis cicatri-*

cosa "Meuschen" Clench, 1944 (*Cassides cicatricosa* Meuschen, 1787 is non-binomial); *Buccinum recurvirostrum* Gmelin, 1791; *Buccinum recurvirostrum* Wood, 1818; *Xenogalea lucrativa* Iredale, 1927; *Semicassis cicatricosa peristephes* Pilsbry and McGinty, 1939. *Cassis plicata* Scopoli, 1786 (*Deliciae Florae et Faunae Insubricae*, pt. 2, p. 76, pl. 24, fig. 1) is a synonym.

Buccinum abbreviatum Gmelin, 1791, does not belong in this synonymy. It is a *Demoulia* in the family Nassariidae. The type of *Cassis lactea* Kiener, 1835, is a *centiquadratum* Valenciennes. Iredale's *lucrativa* is evidently based upon West Indian specimens distributed by Reeve under an incorrect label attributing the shells to "Raine's Island, Torres Strait, Australia." I examined Lamarck's type of *abbreviatum* (44.5 x 30.1 mm.; 6 whorls) and Bruguière's type of *granulosum* (74.4 x 48.9 mm.; 8 whorls) in Geneva, and they are typical West Indian specimens of *granulatum* (Born).

Heretofore, this species has not been recorded from Bermuda, but the late Mr. Ted Nielsen sent us a Pleistocene specimen found at Devon-

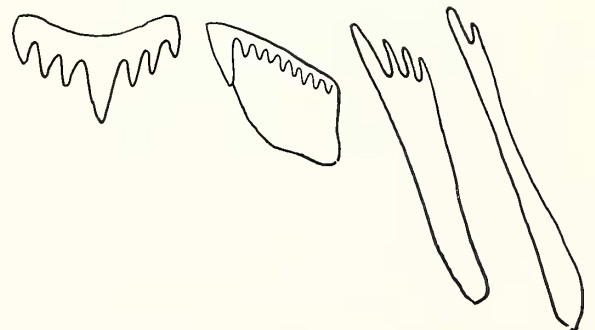


Plate 144. *Phalium* (*Semicassis*) *granulatum* (Born). Radula of female from the Virgin Islands, West Indies.

shire Bay on the south coast of Bermuda. Russell Jensen collected two broken specimens in Castle Harbour Sound in 1967 that were evidently recently killed by octopuses.

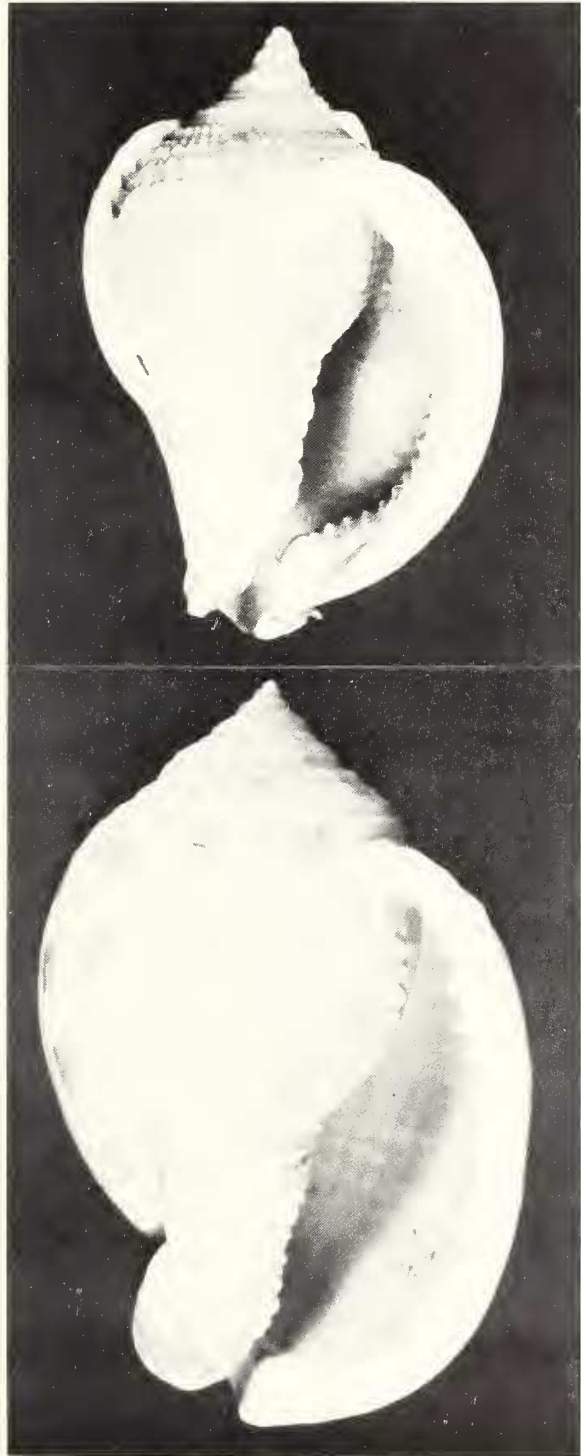


Plate 145. *Phalium* (*Tylocassis*) *granulatum granulatum* (Born, 1778). Top fig., holotype of *Cassis abbreviata* Lamarck, 1822, 44.5 mm. Bottom fig., holotype of *Cassis granulosa* Bruguière, 1792, 74.4 mm. Both types in Mus. d'Hist. Nat. Genève.

***Phalium granulatum subspecies undulatum* (Gmelin, 1791)**

(Pl. 12, figs. 11-15; pl. 148)

Range—Mediterranean; the Azores, Madeira and Canary Islands.

Remarks—This subspecies is characterized by its somewhat produced spire, and by fine, brown spiral lines between the 17 or 18 strong, spiral cords. Above, we have distinguished it from the subspecies *granulatum* (Born) of the Western Atlantic and the subspecies *centiquadratum* (Valenciennes) of the tropical Eastern Pacific. *S. g. undulatum* may sometimes bear small knobs on the shoulder and have a lower spire. It differs from the Eastern Atlantic *saburon* (Bruguière) which is smaller, more globular, has a sealed false umbilicus and has only 3 to 10 small pustules on the lower part of the columellar shield. *P. g. undulatum* is moderately common throughout the Mediterranean.

Measurements (mm.)—

length	width	no. whorls	
111.0	64.0	8	large; Mediterranean
92.0	61.0	9	average; Yugoslavia
91.0	54.5	8	type of <i>sulcosa</i> Bruguière
53.8	34.1	8	small; Spanish Morocco

Synonymy—

- 1791 *Buccinum undulatum* Gmelin, *Systema naturae*, ed. 13, p. 3475, no. 18 (locality not stated); refers to Lister, pl. 996, fig. 61.
- 1791 *Buccinum trifasciatum* Gmelin, *ibid.*, p. 3477, no. 30; refers to Bonanni, fig. 158.
- 1791 *Buccinum bilineatum* Gmelin, *ibid.*, p. 3476, no. 23 (locality unknown). Refers to Lister, pl. 998, fig. 63.
- 1792 *Cassidea sulcosa* Bruguière, *supra cit.*, p. 422 (Jamaica [error]); refers to Bonanni, fig. 159; Petiver, pl. 152, fig. 8; and others. [Non *Buccinum sulcosum* Born, 1778, which is a *Tonna*, and does not preoccupy this name.]
- 1817 *Buccinum horcatum* "Solander" Dillwyn, *Desc. Cat.* vol. 2, p. 595 (nude name).
- 1822 *Cassis sulcosa* Brug., Lamarck, *Anim. sans Vert.*, vol. 7, p. 226.
- 1852 *Semicassis variatum* "Martyn" Mörch, *Catalog Conchyl. Yoldi*, p. 112.
- 1857 *Cassis sulcosa* var. *minor* Küster, Martini and Chemnitz, *Syst. Conchyl.-Cab.*, series 2, vol. 3, pt. 1b, p. 44, pl. 53, figs. 3, 4. (not *minor* Küster, *ibid.*, p. 43.).
- 1868 *Cassis sulcosa* Brug., var. *tuberculata* and var. *globosa* Weinkauff, *Die Conchylien des Mittelmeers*, Cassel, vol. 2, p. 43 (Mediterranean). [form names].
- 1870 *Cassis* (*Cassidea*) *undulata* Gmelin, Hidalgo, *Moluscos Marinos Espana*. . . , vol. 2, *Cassis*, p. 2, pl. 3, fig. 1.
- 1878 *Cassis undulata* var. *ampullacea*, var. *crassa*, var. *elongata*, var. *varicosa*, var. *granulata* [all] Monterosato, *Enum. e Sinon. Conch. Mediterr.*, p. 42 [all form names].
- 1882 *Cassis undulata* Gmelin, Bucquoy, Dautzenberg and Dollfus, *Les Moll. Marins du Roussillon*, Paris, vol. 1, p. 66; 1962, Pasteur-Humbert, *Travaux L'Inst. Sci. Chérifien*, ser. Zool. no. 23, p. 68 (Maroc).

- 1884 *Cassis undata* var. *levilabiata* de Gregorio, Bull. Soc. Mal. Italiana, Pisa, vol. 10, p. 113 (no locality).
 1885 *Cassis ventricosa* Mart., Tryon, Manual of Conchology, vol. 7, p. 274, 299.
 1886 *Cassis gmelini* Locard, Prodrome de Malacologie Française, p. 148 and 556.
 1886 *Cassis decussata* Locard, Prodrome de Malacologie Française, p. 149.
 1892 *Cassis calamistrata* Locard, Les Coquilles Marines de Côtes de France, Paris, p. 89 (Mediterranean). [new name for *Cassis decussata* Locard, 1886, non Linné, 1758].
 1900 *Cassis* (*Semicassis*) *undulata* Linné [sic], var. *minor*, *ex-colore* and *minima* Pallary, Jour. de Conchyl., vol. 48, p. 297, text fig. 7. (Oran).
 1935 *Phalium* (*Semicassis*) *undulatum* var. *marchesei* Bayer, Zoolog. Mededeel. vol. 18, p. 107. New name for *granulata* Monterosato, 1878, non Born, 1778.
 1935 *Phalium* (*Semicassis*) *undulatum* var. *pusio* Bayer, *ibid.*, p. 107. New name for *minor* Küster, 1857, p. 44, non Kuster, 1857, p. 43.

Types—The type locality of “Barbados” given by Gmelin is evidently erroneous. Gmelin may not have had a specimen. Bruguière’s type is in the Museum de Genève.

Nomenclature—Bucquoy, Dautzenberg and Dollfus (1882, p. 66) aptly stated that the synonymy of this shell was very complicated. The

argument has hinged on the recognition of Gmelin’s *Buccinum undulatum* which was poorly described and referred primarily to Lister’s pl. 999, fig. 61. Lister’s figure looks very much like the Mediterranean form (in possessing long wavy, axial color flames and possibly spiral color lines), despite the locality of “Barbados”. I am following the decision of these three authors rather than that of Weinkauff (1878, p. 42) who suggested that Gmelin’s name be rejected. Gmelin evidently had no specimen.

Records—YUGOSLAVIA: Makarska, Adriatic Sea (Jure Radic, ANSP). GREECE: Mikonos Id. (Katherine Anderson, ANSP); Delos Id. (MCZ). ITALY: Taranto; Naples; Ustica Id., n. of Sicily (all Weinkauff, 1867, p. 42); Syracuse, Sicily (M. Smith, 1909, Nautilus, vol. 22, p. 132); Palermo, Sicily (Zool. Mus., East Berlin); Gallipoli (USNM); Aci Trezza, Sicily (ANSP). FRANCE: Marseilles; Toulon (both Mus., Roy. Hist. Nat. Belg.); St. Tropez (R. Robertson, ANSP); Corsica Id. (USNM; MCZ). SPAIN: Barcelona (Mus. Roy. Hist. Nat. Belg.); Mallorca Id., Balearic Ids. (ANSP). LIBYA: Tripoli (Weinkauff, 1867, p. 42); ALGERIA: Port Gueydon (Ancey, 1898, Nautilus, vol. 12, p. 52); Cap Falan, near Oran; Bone (Mus. Roy. Hist. Nat. Belg.); Algiers (MCZ). SPANISH MOROCCO: Mèlilla (Cayetano, ANSP). AZORES: Pico (Mus. Roy. Hist. Nat. Belg.). MADEIRA IDS: Porto Santo (MCZ). CANARY IDS.: La Luz, Grand Canary (Mus. Roy. Hist. Nat. Belg.); Tenerife Id. (MCZ).

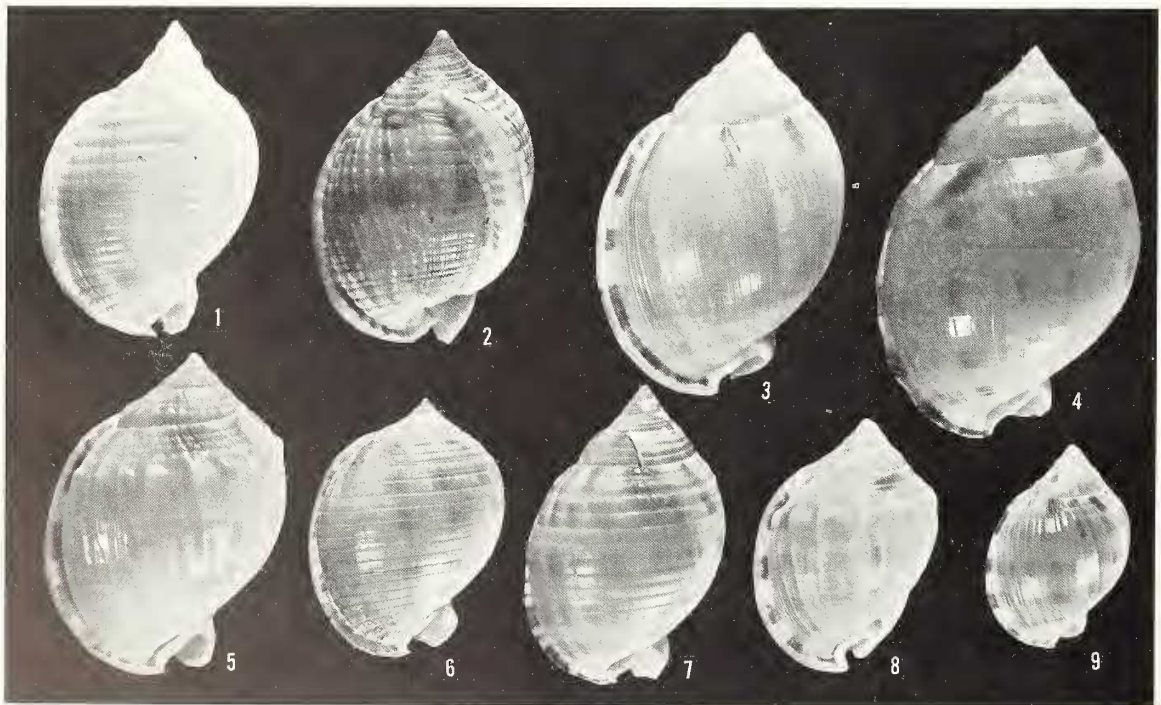


Plate 146. Sculptural variations in *Phalium* (*Tylocassis*) *granulatum* (Born, 1778). Fig. 1, off Pensacola, Florida, 42 mm. Fig. 2, Mayaguez, Puerto Rico, 44 mm. Fig. 3, smooth form *cicatricosum* (Gmelin) from St. Thomas, Virgin Islands, 50 mm. Fig. 4, 3 fms., off Key West, Florida, 75 mm. Fig. 5, holotype of *peristephes* Pilsbry and McGinty,

1939, from Boynton Inlet, Florida, 44.6 mm. Fig. 6, ovate form from Obregon, Yucatan, Mexico, 48 mm. Fig. 7, Eighth Pass, N.E. Mexico, 59 mm. Fig. 8, dwarf, noduled form from Guantanamo Bay, Cuba, 34 mm. Fig. 9, dwarf, smoothish form from Guantanamo Bay, Cuba, 28 mm.



Plate 147. *Phalium* (*Tylocassis*) *granulatum* forma *cica-tricosum* (Gmelin, 1791). Holotype of *Xenogalea lucrativa* Iredale, 1927, erroneously attributed to Torres Straits, Australia.

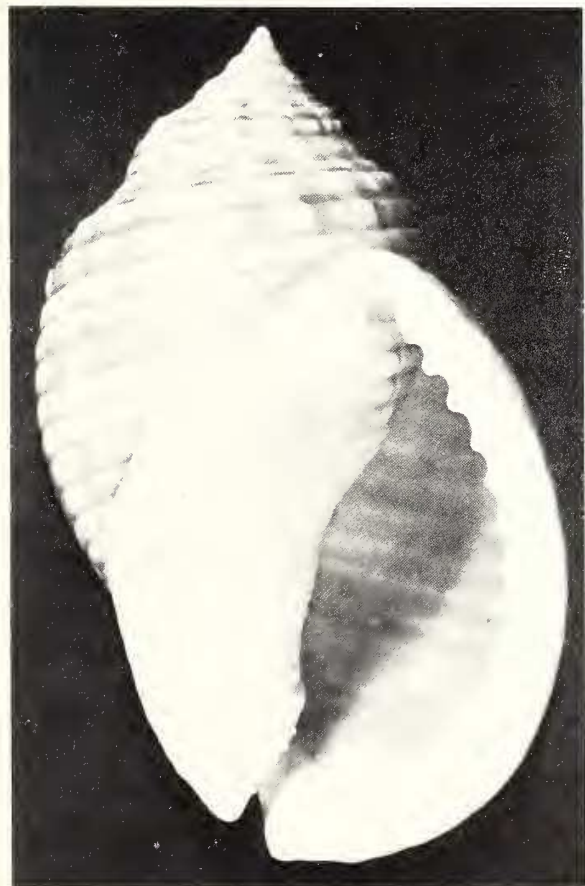


Plate 148. *Phalium* (*Tylocassis*) *granulatum undulatum* (Gmelin, 1791) from the Eastern Atlantic. Holotype of *Cassissulcosa* Bruguière, 1792, 91 mm. Mus. d'Hist. Nat. Genève.

***Phalium granulatum subspecies centriquadratum* (Valenciennes, 1832)**

(Pl. 12, figs. 8, 9; pl. 149)

Range—Lower California, Mexico to Northern Peru; Galapagos.

Remarks—The distinguishing characters of of this moderately common Eastern Pacific cassid are given above. The shell is very variable in sculpture and ranges in size from 33 to 69 mm. (1-1/3 to 2-3/4 inches). The same dwarf, thick-shelled, beaded form exists in both *centriquadratum* and the Caribbean *granulatum*. The monstrosity illustrated by Bayer (1935, p. 103, fig. 2) is merely a formerly two-variced specimen which has been broken back. Some live-collected shells have a bluish gray background. I have examined Kiener's type of *lactea* (41.1 x 29.0; 6.5 whorls) in the Museum de Genève, and believe it to be a synonym of this subspecies. Clench (1944) thought it to be the Caribbean subspecies.

Emerson and Old (1963), p. 16 report living specimens from 20 to 24 fathoms from Baja California.

Synonymy—

- 1832 *Cassissulcosa centriquadrata* Valenciennes in Humboldt and Bonpland, Recueile d'Observ. Zool, vol. 2, p. 310 (Acapulco).
- 1832 *Cassissulcosa dolata* Valenciennes, *ibid.*, p. 311.
- 1835 *Cassissulcosa lactea* Kiener, Coquilles Vivantes, Paris, vol. 8, p. 35, pl. 16, fig. 35 (locality unknown).
- 1935 *Phalium granulatum* subsp. *abbreviata* var. *centriquadrata* (Val.) Bayer, Zoologische Mededeelingen, vol. 18, p. 102, 103, fig. 2.
- 1958 *Cassissulcosa (Semicassissulcosa) centriquadrata* (Valenciennes, 1832), Keen, Sea Shells of Tropical West America, Stanford, p. 340, fig. 315.
- 1963 *Semicassissulcosa centriquadrata* (Val.), Emerson and Old, Amer. Mus. Novitates, no. 2153, p. 16.

Records—MEXICO: La Libertad, Sonoro (H. N. Lowe, ANSP; MCZ); Miramar, Guaymas (Ted Dranga, MCZ); Santa Rosalia (H. G. Richards, ANSP); San José Id. (USNM); Agua Verde Bay (USNM); Mangrove Id., Magdalena Bay, Lower Calif. (USNM); La Paz (W. M. Gabb, ANSP); Cape San Lucas (USNM; MCZ); Sta. Inez Bay; Santa Maria Bay (both USNM); Mazatlan (Ruth Ostheimer, ANSP); off Guaymas, 71 fms. (USNM); Acapulco (ANSP; USNM); Salina Cruz, Oaxaca (M. E. Bourgeois, ANSP). COSTA RICA: Puntarenas (H. N. Lowe, MCZ). COCOS ID: Wafer Bay (Paul Slud, AMNH). PANAMA: (ANSP; MCZ; USNM). COLOMBIA: Tumaco (Zool. Mus. Copenhagen); Isla de la Gallo (ANSP). ECUADOR: Cojimies (Ted Dranga, ANSP; MCZ); Manta (USNM; ANSP); Jumaco (Zool. Mus. East Berlin). PERU: Lobitos and Mancora (Olsson, 1924, Nautilus, vol. 37, p. 125). GALAPAGOS: Eden Island, off Santa Cruz Id. (Victor Zullo, 1964, ANSP).

Fossil records—PLIOCENE: Jama formation, Puerto Jama, Ecuador (Pilsbry and Olsson, Proc. ANSP, vol. 93, 1941, p. 40, pl. 7, figs. 3, 6).



Plate 149. *Phalium* (*Tylocassis*) *granulatum* subspecies *centiquadratum* (Valenciennes, 1832). Pliocene, Canoa formation. Punta Blanca, Ecuador. 47 mm. in length.

Phalium granulatum
subspecies aldrichi Dall, 1890

(Pl. 150)

Range—Miocene of Florida (and Canal Zone?).

Remarks—This is one of the numerous fossil forms of *granulatum*. It is morphologically closer to the Recent Pacific subspecies, *centiquadratum*. This may be a form of *reclusum* Guppy, 1873. Woodring (1959, p. 199) says "the wart-like denticles of the type and only specimen of *aldrichi* do not extend over the parietal wall as shown in Dall's [original] illustration. . . ."

Synonymy—

- 1890 *Phalium aldrichi* Dall, Transactions Wagner Free Inst. Science, Philadelphia, vol. 3, pt. 1, p. 162 (Lower Miocene of the Chipola beds, N.W. Florida, at Ten-Mile Creek); 1892, pt. 2, p. 263, pl. 21, fig. 2.
1947 *Semicassis* (*Tylocassis*) *aldrichi* (Dall), Gardner, U.S. Geol. Survey Prof. Paper 142-H, p. 536, pl. 54, fig. 6.
1959 *Semicassis* ? (*Tylocassis* ?) cf. *S. aldrichi* (Dall), Woodring, U.S. Geol. Survey Prof. Paper 306-B, p. 199 (Culebra formation, Canal Zone, early Miocene).

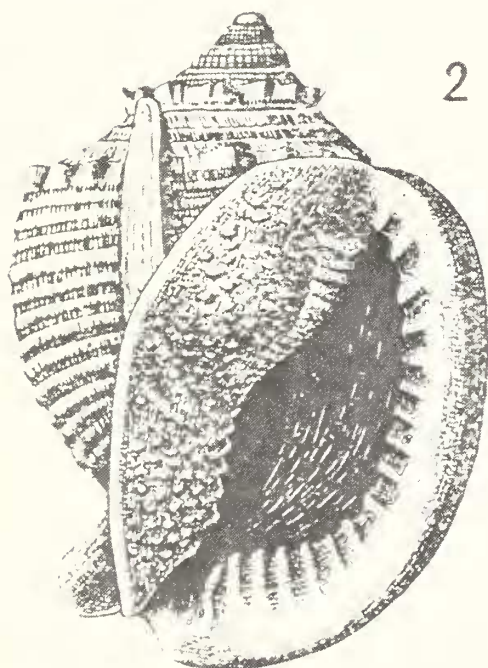


Plate 150. *Phalium* (*Tylocassis*) *granulatum* subspecies *aldrichi* Dall, 1890. Chipola River, N.W. Florida. Miocene. Length: 26 mm. Holotype from Dall, 1893 [1892 on title page], vol. 3, pt. 2, pl. 21, fig. 2.

Phalium granulatum
subspecies reclusum (Guppy, 1873)

Range—Miocene of the Caribbean.

Remarks—This is the supposed Miocene progenitor of the Recent *granulatum* and *centiquadratum*. Numerous ecologic and genetic forms exist; most of those having been collected have had names applied to them, as can be seen in the synonymy below. The differences between these Miocene forms and the Recent colonies are probably too slight to justify anything more than form names.

Synonymy—

- 1866 *Cassis monilifera* Guppy, Quart. Journ. Geological Society London, vol. 22, p. 287, pl. 17, fig. 8 (Miocene, Jamaica). Non Sowerby, 1846. Type in Brit. Mus. Paleo. Dept. no. 64074, 24.0 x 17.1 mm.; 1874, Geol. Mag., decade 2, vol. 1, p. 439 (list); 1876, Quart. Jour. Geol. Soc. London, vol. 32, p. 525; 1917, Pilsbry and Brown, Proc. Acad. Nat. Sci. Philadelphia, vol. 69, p. 34 (Colombia, Miocene); 1925, Maury, Brasil Serv. Geol. Mineral. Mon., vol. 4, pl. 5, fig. 1.
1873 *Cassis reclusa* Guppy, Proc. Sci. Assoc. Trinidad, vol. 2, no. 2, p. 84 (Miocene, Jamaica).
1917 *Phalium moniliferum* (Guppy), Maury, Bull. Amer. Paleontology, vol. 5, p. 110, pl. 44, figs. 4-5, pl. 45, fig. 1.
1928 *Semicassis* (*Tylocassis*) *reclusa* (Guppy), Woodring, Carnegie Institute, Wash. D.C., Publ. no. 385, p. 307, pls. 19 and 20; 1959, U.S. Geol. Survey, Prof. Paper 306-B, p. 200, pl. 34, figs. 1, 4-6.
1925 *Phalium paraensis* Maury, Brasil Serv. Geol. Mineral. Mon., vol. 4, p. 119, pl. 5, figs. 5-7 (Rio Pirabas, Brasil; lower Miocene).
1934 *Phalium* (*Tylocassis*) *sulcosum* var. *semiti* Rutsch, Abhandl. Schweizer. Palaeont. Gesell., vol. 54, p. 55, pl. 3, fig. 1, 2 (Miocene, Punta Gavilan formation of Venezuela). Spire higher.
1935 *Semicassis* (*Tylocassis*) *inflata waltonensis* Mansfield, Geol. Bull. no. 12, Dept. of Conservation, Florida, p. 40, pl. 4, figs. 5, 9 (Station 12046, Vaughan Creek, Walton Co., Florida; Upper Miocene).
1938 *Semicassis* (*Tylocassis*) *maleaformis* Vokes, American Museum Novitates, no. 988, p. 24, fig. 22 (Upper Miocene, Springfield, Trinidad). Badly crushed specimen.

Phalium caelaturum (Conrad, 1848)

Range—Oligocene of Vicksburg, Mississippi.

Remarks—This species bears small *Tylocassis*-like pustules on the lower part of the columellar shield. The more elongate shape of the entire shell and the rather strong, sharp beads on the body whorl distinguish this unique species from the *granulatum-reclusum* series. Types in ANSP nos. 13499 and 13500.

Synonymy—

- 1847 *Cassis caelatura* Conrad, Proc. Acad. Nat. Sciences Philadelphia, vol. 3, p. 288 (Vicksburg, Mississippi).
1922 *Cassis* (*Phalium*) *caelatura* Conrad, Pilsbry, Proc. Acad. Nat. Sci. Phila., vol. 73, p. 362 (chart).

[These occasional blank areas occur between genera and subgenera to permit the insertion of new material and future sections in their proper systematic sequence.]

Subgenus *Xenophalium* Iredale, 1927

Type: *Phalium pyrum royanum* (Iredale, 1914)

Members of this subgenus generally live in cold temperate waters. The shells closely resemble those of the subgenus *Semicassis*, but differ in having a much smoother columellar shield, fewer denticles or tooth-like lirae on the outer lip and in seldom having strong spiral sculpturing. There is a dark-brown color splotch on the end of the siphonal notch in most species. The tentacles of most species examined bore two long, narrow longitudinal stripes. The penis has an open seminal groove running to the distal end, and, unlike other *Phalium*, has numerous fleshy papillae on the surface of the underside. The outer marginal radular tooth usually lacks denticles. The operculum is fan-shaped and usually smoothish.

Of the six known species, five are found in the southern hemisphere and one in Japan. One species, *labiatum*, is circum-antarctic in its distribution. Shells in this subgenus are renowned for the variability in shape and sculpturing, a fact which has led to the description of the many ecologic and minor genetic forms found in South Australia and New Zealand. *Xenogalea* Iredale is a synonym based upon species which usually show some denticulation on the outer lip.

The name *Eocasmaria*, with *Cassidea gradifera* Cossmann and Pissarro, 1909, as the type, was proposed by Vredenburg in 1928 as a new section of the subgenus *Semicassis*. This Eocene shell resembles the tabulated forms of some Australian *Xenophalium*, but because the shells are not at all well-preserved, and because the thin, outer lip suggests a juvenile form, I hesitate to accept *Eocasmaria*. It certainly bears no resemblance to the Recent *Casmaria*.

Synonymy—

1927 *Xenophalium* Iredale, Records Australian Museum, vol. 15, p. 333. Type by original designation: *Xenophalium hedleyi*, 1927.

1927 *Xenogalea* Iredale, Records Australian Museum, vol. 15, p. 339. Type by original designation: *Cassis pyrum* Lamarck, 1822.

?1928 *Eocasmaria* Vredenburg, Memoirs Geol. Survey India, Palaeontologia Indica, new ser., vol. 10, no. 4, p. 41. Type by original designation: *Cassidea gradifera* Cossmann and Pissarro, 1909.

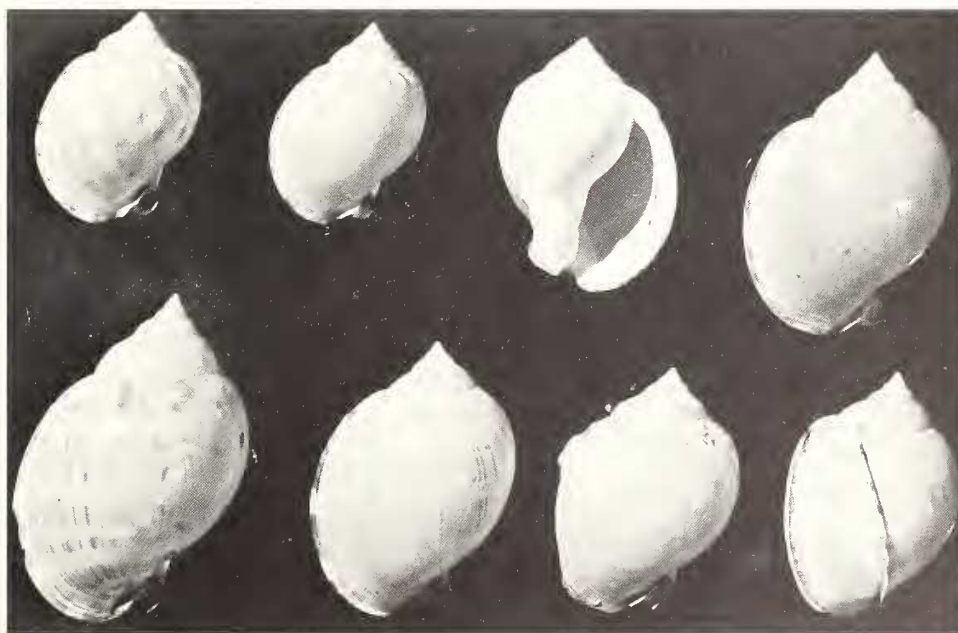


Plate 151. Variations in sculpturing and color patterns in *Phalium* (*Xenophalium*) *pyrum* (Lamarck, 1822) from off Eden, New South Wales. Collected by Neil F. Buckland,

1962. Top left shell with two rows of nodules is 55 mm. in length; others to same scale. Lower right shows extra varix.

***Phalium pyrum* (Lamarck, 1822)**

(Pls. 13, 151-157)

Range—Southern Australia, Tasmania, New Zealand and South Africa.

Remarks—I have examined many hundreds of specimens of this group from about one hundred different localities in Australia, Tasmania and New Zealand, and have come to the conclusion, not without apprehension, that the host of species described by Cotton, Iredale, Powell and others are in reality nothing but local ecologic forms or random, local, concentrations of minor genetic forms. I have before me collections of a dozen or more specimens from one locality representing several "species" but which, through a series of specimens, show gradual intergradation in shape, coloring and sculpture. Most of these so-called species were based upon one or two specimens brought into museums over the years by deep-water fishermen. The first non-typical form was described as *niveum* by Brazier in 1872. It was a small, whitish, shouldered specimen, bearing two spiral rows of small, rounded nodules, and was collected by W. F. Petterd, Jr. at Macquarie Harbour, west Tasmania. Since then, similar specimens have been found in Victoria, Western Australia, and New South Wales, together with specimens having more elevated spires and less pronounced nodules on the shoulder. Around this form, which may range in size from 45 to 90 mm., and vary from white to brownish peach, are several similar but intergrading forms which have received the species names of *spectabile* Iredale, 1929, and *mawsoni* Cotton, 1954.

In 1914 Hedley described *stadiale* which is the dominant form off southeast Australia. Other specimens collected by the F.I.S. "Endeavour" at the same time and in the same areas, and having intergrading characters, were evidently not seen by Hedley. They are now in the National Museum of Victoria and bear labels reading "*C. stadialis* var.". Had Hedley seen other specimens, he doubtlessly would have connected his *stadiale* with typical *pyrum*. Other workers, believing that size, thickness of shell, development of columellar plicae, outer lip dentition and shoulder nodulation were species criteria, gave species names to some of the forms similar to if not identical with *stadiale*, such as *denda* Cotton, 1954, *halli* Cotton, 1954 and *wilsoni* Cotton, 1954.

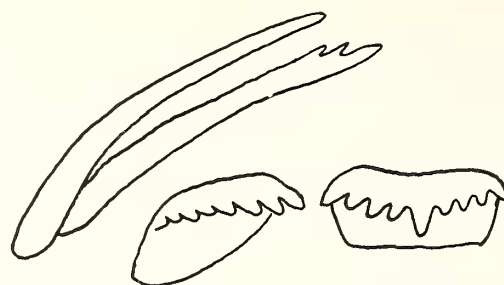


Plate 152. *Phalium pyrum* (Lamarck). Radula of forma *hamiltoni* from New Zealand. (After Powell, 1928, p. 632).

In New Zealand considerable attention has been given to the *pyrum* complex, both Recent and fossil. Although many areas around New Zealand, particularly on the west side, are yet to be sampled for cassids, a pattern of distribution is evident from the specimens at hand. In the relatively shallow inshore waters one finds the common, colorful, noded form which New Zealand workers refer to as typical *pyrum*. It has been more commonly collected around North Island. An ecologic shallow-water cline appears to be present towards the south in which the shells become heavier, with attending denticles on the inside of the outer lip and slightly stronger plicae on the columella. This is a common phenomenon in other cassids when the ends of the range extend into cooler waters. This heavier form reaches its maximum expression at the south end of South Island and just across Foveaux Strait around Stewart Island. It is forma *harrisonae* (Powell, 1928). This forma was also produced during the Upper Pliocene at Castlecliff, Wanganui, North Island, suggesting that ecologic conditions were similar to those of today. The persistence of minor genetic and/or ecologic forms from even as early as the Miocene is not an uncommon phenomenon in cassids and other families, and the element of what seems to be a long time to man should not influence the recognition of separate species names for the fossils.

Another major cline in the New Zealand *pyrum* complex is correlated with depth of water and, hence, probably with temperature, salinity, bottom sediments and water flow. Along the shelf off the eastern sides of South Island and the southern half of North Island a host of smooth, more or less globose and less colorful forms have been dredged in 40 to 155 fathoms. Some specimens intergrade with typical *pyrum*. Off Castlepoint, southeast North Island, and off

other areas near Wellington in 2 to 70 fathoms several of the named forms (*hamiltoni*, *powelli*, *abernethyi* and their intergrades) have been brought up, sometimes in the same trawl net. The forma *finlayi* (Iredale, 1927) is common to the south near Otago Peninsula in 45 to 80 fathoms. Doubtlessly, other deep-water forms will be found there when more samples are taken. Both Australian and New Zealand workers tend to recognize deep water, ecologic forms as species, but inevitably the intergrades are sooner or later collected in shallower water. The forma *finlayi* does not differ significantly from the Australian forma *stadialis* (Hedley, 1914), except that the former may have stronger, incised lines on the early postnuclear whorls and on the base of the body whorl. Rather significantly, Dell (1956, p. 87) points out that his *abernethyi* "combines in part the shape of *hamiltoni* Powell with the denticulate aperture of *harrisonae* Powell." Other combinations are also evident.

As in the case in the widely distributed *Phalium* (*Semicassis*) *bisulcatum* (Schubert and Wagner), the type of bottom and the depth and temperature of water seem to produce about the same kind of ecotypes. In the New Zealand deep-water *pyrum*, the shell tends to be darkly stained, eroded, lustre-less, somewhat globose and generally with more thickened shell walls. These colonies have received such names as *abernethyi* Dell, 1956, *hamiltoni* Powell, 1928, *finlayi* Iredale, 1927, and *matai* Powell, 1952.

Curiously, the rather distinct form found commonly cast up on the beaches of Mangawai, Hokeo, Muriwai and Great Barrier Island has

not received a name. It differs from Lamarck's type of *pyrum* from South Australia in being usually smaller, with more numerous nodules on the shoulder and in being very brightly colored with spiral rows of red-brown squares, arrows or zigzag blotches. Specimens intergrade with the other New Zealand forms already described, and if one were to name this colorful form, it would necessitate applying names to the other numerous variants as well. There are specimens from Ulberstone, northern Tasmania, which are almost indistinguishable from some North Island, New Zealand, specimens, suggesting not only a similar environment, but also suggesting the possible and not too geologically-distant origin of the New Zealand immigrants.

South African specimens of typical *pyrum* are evidently rare, at least in collections, and some of them show *labiatum* characters such as a thick, glossy surface and white spotting. As I mentioned under the remarks of *labiatum*, South African specimens in this complex show such an extraordinary variation that it is difficult to conclude if hybridization is occurring between *pyrum* and *labiatum* or if some South African *labiatum* are expressing ancestral *pyrum*-like features.

Reports of *pyrum* from Mauritius are based on a Liénard Collection specimen which I have seen in the Mauritius Institute collection. I suspect that the shell came from South Africa. Shell specimens have been turning up in Fiji, but they look suspiciously like specimens from New South Wales.

It is characteristic of small cassids elsewhere in the world not only to exhibit remarkable indi-

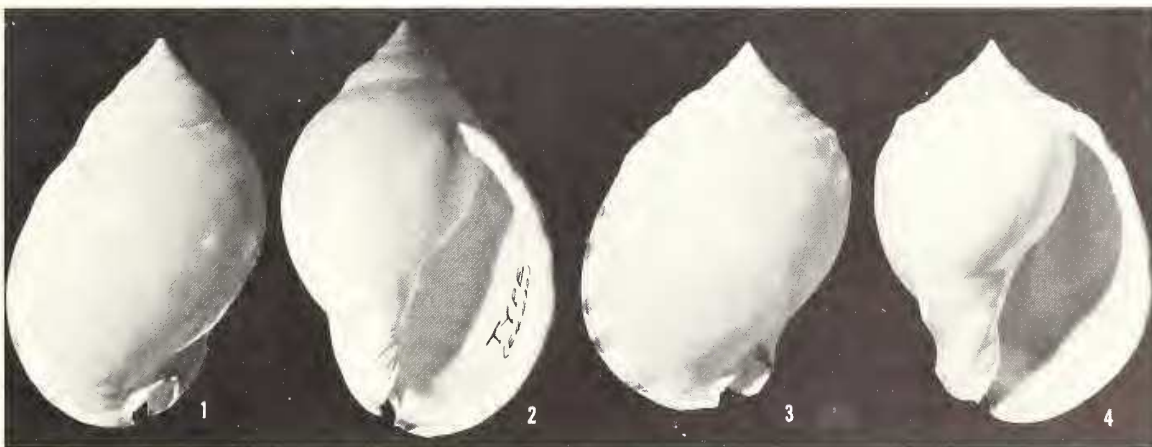


Plate 153. *Phalium* (*Xenophalium*) *pyrum* (Lamarck). Australian forms. Figs. 1 and 2, holotype of *Cassidea stadialis* Hedley in the Australian Museum no. E. 4430, between Green Cape and Gabo Island, southeast Australia. Figs. 3

and 4, holotype of *Xenogalea spectabilis* Iredale in the Australian Museum no. C. 57722, off Montague Island, New South Wales. (photos courtesy of D. F. McMichael).

vidual variation, but also to congregate some of these variations within very local and perhaps somewhat isolated colonies. These colonial concentrations may reflect local environmental conditions, but they may also represent a more or less uniform genetic similarity brought in through successful swarms of free- and long-swimming veligers.

This "lumping" view is not necessarily correct in all cases, but the present alternative would be to continue describing each colony or unusual variant as new. I have before me numerous variations which are undescribed, and a "splitting" treatment of them would doubtless result in several dozen new species. In view of the probably long-swimming larval stage in all cassids and because of the available migratory ocean currents, I believe it would be unwise to elevate forms or local variants to the rank of species or subspecies.

I have included as large a series of photographs of these forms as space and expense will allow, and have retained several well-known names as *forma*. Should subsequent experimentations and research prove these to be good species, they may be elevated once again to species or subspecies rank.

Below is an outline of the subspecies and *forma* of *pyrum* which seem worthy of recognition for possible use in ecologic and distributional surveys. The recognition of the forms is arbitrary, since so many intergrades exist.

subspecies pyrum (Lamarck, 1822). Tasmania; Australia; New Zealand; South Africa.

forma stadiale (Hedley, 1914). Southeast Australia. (syn.: *denda* Cotton, 1945; *wilsoni* Cotton, 1954; *halli* Cotton, 1954).

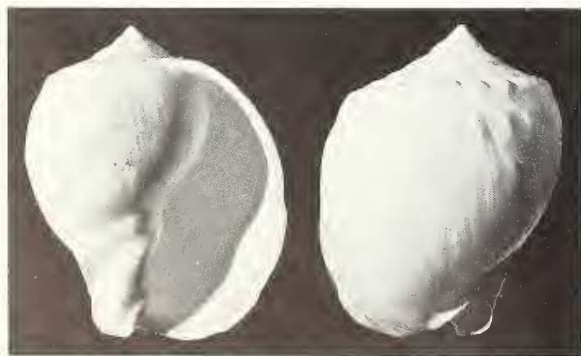


Plate 154. *Phalium* (*Xenophalium*) *pyrum* (Lamarck) *forma niveum* (Brazier, 1872). Holotype of *Cassis nivea* Brazier in the Australian Museum no. C. 11498 from Macquarie Harbour, Tasmania. 51 mm. in length. (photos courtesy of D. F. McMichael).

forma niveum (Brazier, 1872). Southeast Australia. (syn.: *mawsoni* Cotton, 1945).

forma spectabilis (Iredale, 1929). Southeast Australia.

forma finlayi (Iredale, 1927). New Zealand. (syn.: *matai* Powell, 1952).

forma hamiltoni (Powell, 1928). New Zealand. (syn.: *abernethyi* Dell, 1956).

forma wanganniense (Powell, 1928). Upper Pliocene, New Zealand.

forma powelli (Finlay, 1928). New Zealand.

forma harrisonae (Powell, 1928). New Zealand.

subspecies royanum (Iredale, 1914). Australia-N.Z.-Kermadecs.

forma ericanum (Powell, 1928). New Zealand.

forma hedleyi (Iredale, 1927). New South Wales.

Description (of Lamarck's type of pyrum)—Adult shell moderately heavy, solid, ovate, and with 8 whorls. Length 63.2 mm; width 44.0 mm. Color of outer shell dirty yellow-brown with reddish brown (ecologic) staining. Nuclear whorls 3, white and smooth. Post-nuclear whorls with 8 to 10 fine spiral threads crossed by numerous axial growth lines. The most prominent thread on the shoulder of the whorl becomes stronger in the penultimate whorl and bears about 24 small, evenly-sized beads. In the last whorl the cord disappears and the beads develop into axially pinched small knobs. Below the suture is a distinct spiral incised line. At the base of the whorl there are 3 or 4 very weak spiral incised lines. Last varix moderately developed, white, with 5 weak, brown spots, and is reflected. True umbilicus small but very deep; false umbilicus chink-like. Parietal and columellar area heavily glazed with enamel-white. Columella with 4 very weak plicae in the middle and bounded below with a larger, single plica. Inside of aperture dark-brown. Siphonal canal short, its end with a dark, chocolate-brown splotch. Channel between the siphonal canal and base of body whorl is moderately wide and rounded in cross-section.

Synonymy (see also under forma)—

1822 *Cassis pyrum* Lamarck, Anim. sans Vert., Paris, vol. 7, p. 226, no. 16 (Nouvelle-Hollande); 1835, Kiener, Coquilles Vivante, Casque, vol. 8, p. 39, pl. 13, fig.

25 (type), pl. 15, fig. 30; 1867, Angas, Proc. Zool. Soc. London, p. 197; 1857, Küster, Martini and Chemnitz's System. Conchylien-Cab., vol. 3, pt. 1b, pl. 47, figs. 5, 6; 1859, Chenu, Manuel de Conchyl., Paris, vol. 1, p. 207, fig. 1130.

- 1840 *Cassidea pyrum* Lam., Swainson, Treatise on Malacology, London, pt. 2, p. 299.
- 1873 *Semicassis (Casmaria) paucirugis* Menke, Brazier, Proc. Zool. Soc. London, for 1872, p. 838; 1877, Angas, Proc. Zool. Soc. London, for 1877, p. 183.
- 1886 *Cassis tumida* Petterd, Papers and Proc. Royal Soc. Tasmania, for 1885, p. 321 (near River Leven).
- 1913 *Phalium (Cassidea) labiatum* subsp. *pyrum* Lamarck, Suter, Manual New Zealand Mollusca, Wellington, p. 312, pl. 40, fig. 13.
- 1913 *Phalium labiatum striatum* Hutton, Suter, *ibid.*, p. 312. Not *striatum* Hutton, 1873.
- 1924 *Phalium pyrum* Lamarck, Iredale, Proc. Linn. Soc. New South Wales, vol. 49, p. 254 (in part); 1935, Bayer, Zoolog. Mededeel, Leiden, vol. 18, p. 110.
- 1924 *Cassis pyra* Lam., Finlay, Trans. Proc. New Zealand Inst., vol. 55, p. 524.
- 1927 *Xenogalea pyrum* (Lamarck), Iredale, Record Australian Mus., vol. 15, p. 339, pl. 32, figs. 14, 16; 1962, Macpherson and Gabriel, Marine Molluscs of Victoria, Melbourne, p. 146, fig. 175.
- 1928 *Xenophalium pyrum* (Lamarck), Powell, Trans. Proc. New Zealand Inst., vol. 59, p. 638, figs. 20-22; 1961, Powell, Shells of New Zealand, pp. 11, 38, 93, pl. 1, fig. 14.

Types—The type of *pyrum* Lamarck, 1822, is in the Museum de Genève. The type locality is "Nouvelle-Hollande". Iredale (1927, p. 340) suggested that the type probably was collected by Péron and Lesueur in southern Tasmania, and Cotton (1954, p. 4 of No. 4: Family Cassididae, Roy, Soc. So. Aust., Mal. Sect.) designated southern Tasmania as the type locality.

Records—(for specimens which closely resemble the type of *pyrum* or have a moderate degree of variation). SOUTH AFRICA: 60 fms., off Mossel Bay, Cape Province; from fish stomach, off Durban, Natal (both Helen Boswell, ANSP). AUSTRALIA: SOUTH AUSTRALIA: Middleton (MCZ); Encounter Bay (USNM). VICTORIA: Portland; San Remo; Western Port; Green Cape to Gabo Id., "Endeavour"; Lakes Entrance; Bass Straits; Port Sea (all Nat. Mus. Vict.); Richmond, near Melbourne (A. F. Kenyon, ANSP); between Flinders and Gabo Id., deep water (West. Aust. Mus.). TASMANIA: Georgetown (USNM); Port Sorell (MCZ); Clark Id.; Maria Id.; Buchmakers Beach (all Nat. Mus. Vict.); between Ulverstone and Stanley (Joy Kerslake, ANSP); Fredrick Henry Bay (G. Pridmore, 1967, ANSP); Pegg's Beach, Stanley (Joy Kerslake coll.). NEW ZEALAND: NORTH ISLAND: Ahipara, Ninety Mile Beach; Motutara, Muriwai; Hokeo Beach, near Levin (all V. Orr, ANSP); Whangarei Heads (Lorna Seager, ANSP); Mangawai (A. Jeakings, Auck. Mus., ANSP); Whangapoua Beach, Great Barrier Id., (Dom. Mus.); Tauranga; Ohope Beach; Moari Bay, Auckland (all MCZ); Cape Colville (ANSP); Mount Maunganui (ANSP); Whakatane (B. R. Bales, ANSP); Paraparauma (MCZ; ANSP); Castlepoint (Dom. Mus.); Waikanae, Wellington (Dom. Mus.; MCZ). SOUTH ISLAND: West Haven Heads, Nelson (A. W. B. Powell, Auck. Mus.; ANSP); Middle Bank, 30 fms., off Kaitioura (F. Abernethy, Dom. Mus.). [forma *harrisonae* (Powell, 1928); Mason's Bay, Stewart Id. (Dom. Mus.; MCZ; ANSP; Auck. Mus.); Te Waewae Bay, Southland, South Id. (Dom. Mus.).]

Fossil records—NEW ZEALAND: UPPER PLIOCENE: Castlecliff, Wanganui, North Island (forma typical; forma *wanganuiense* (Powell, 1928) and forma *harrisonae* (Powell, 1928), fide Powell, 1928, p. 638.

Australian Forms

forma *stadiale* (Hedley, 1914)

(Pl. 13, fig. 11; pl. 153, figs. 1, 2)

Range—Southeastern Australia, Tasmania, 15 to 100 fathoms.

Remarks—This name was placed upon a specimen taken by the F.I.S. "Endeavour" in 50 to 100 fathoms between Green Cape and Gabo Island, southeast Australia. The shell is rather light in weight, smooth shouldered, with a moderately high spire, light-buff to yellowish with sparse blotches of brownish arranged in spiral rows. Below the suture there is a single weak, incised line or indentation. The lower third of the columella has 7 or 8 weak, spiral plicae. The base of the body whorl has 3 or 4 very weak, spiral lines. From the same trawl haul off Australia the "Endeavour" secured variants showing weak nodules on the shoulder. Other variants from New South Wales have a smoother columellar shield and zigzag axial flames of chestnut brown. The New Zealand analogue is forma *finlayi* (Iredale, 1927). The type of *stadiale* is in the Australian Museum, no. E 4430. Of the synonyms created by Cotton, *halli* is the only mature and well-colored specimen, which shows weak dentitions on the outer lip and weak plicae on the inner columellar region.

Measurements (mm.)—

length	width	no. whorls	
87.1	58.0	7+	holotype of <i>wilsoni</i> Cotton
85.5	53.7	8	holotype of <i>halli</i> Cotton
84.9	60.0	8	holotype of <i>denda</i> Cotton

Synonymy—

- 1902 *Cassidea turgida* Hedley, Mem. Australian Mus., vol. 4, p. 340, pl. 36, fig. 1.
- 1914 *Cassidea stadialis* Hedley, Biol. Results, F.I.S. "Endeavour", vol. 2, p. 72, pl. 10, fig. 4 (between Green Cape and Gabo Id.).
- 1916 *Cassis achatina* var. *stadialis* Hedley, Gatliff and Gabriel, Proc. Roy. Soc. Vict., vol. 29, p. 108.
- 1918 *Phalium stadiale* Hedley, Hedley, Jour. Roy. Soc. New South Wales, vol. 51, p. M 67.
- 1927 *Xenogalea stadialis* (Hedley), Iredale, Record Australian Mus., vol. 15, p. 341, pl. 31, fig. 3; 1962, Macpherson and Gabriel, Marine Moll. Victoria, Melbourne, p. 151, fig. 179.
- 1945 *Xenogalea denda* Cotton, Trans. Roy. Soc. South Australia, vol. 69, no. 1, p. 169 (100 fms., west of Eucla); 1945, *ibid.*, no. 2, p. 250, fig. A. Type in the So. Aust. Mus., no. D 5332.
- 1954 *Xenogalea halli* Cotton, No. 4: Family Cassididae, Mal. Sect., Roy. Soc. South Australia, 2nd page, fig. 15 (off West Island, 15-16 fms., Victor Harbour). Type in the So. Aust. Mus., no. D 14509).
- 1954 *Xenogalea wilsoni* Cotton, above citation, fig. 16, and same type locality. Type in the So. Aust. Mus., no. 5331.

Records—(for specimens which closely resemble the type of *stadiale*, but which also may have weak or obsolete nodules on the shoulder). WESTERN AUSTRALIA: 100 fms., off Eucla, Great Australian Bight (Cotton's *denda*, 1945, p. 169); 15-16 fms., off West Island, Victor Harbour, near Adelaide (Cotton's *halli*, 1954, p. 2); deep water, Kingston (West Aust. Mus.); from lobster pot, off Southend (Joy Kerslake, coll.). VICTORIA: off Portland (T. A. Garrard, coll.); off San Remo; Bass Straits; Lakes Entrance (all Nat. Mus. Vict.). TASMANIA: Buchmakers Beach; Three Hummock Id. (all Nat. Mus. Vict.). NEW SOUTH WALES: between Gabo Id. and Green Cape, 50-100 fms., F.I.S. "Endeavour" (Nat. Mus. Vict.); 25-100 fms., off Eden (Neil F. Buckland, ANSP); 60 fms., off Eden (Vernon Wells, MCZ); off Ulladulla (Joy Kerslake, coll.); off Port Stephens; off Forster (ANSP); 80 fms., off Mosman (B. Kaspiew, ANSP); dredged south of Montague Id. (R. Rixon, MCZ); off Sydney Heads (Mel Ward, MCZ).

forma niveum (Brazier, 1872)

(Pl. 13, fig. 13; pl. 154)

Range—Southeastern Australia and Tasmania.

Remarks—This name was placed upon a somewhat immature specimen from Macquarie Harbour, west Tasmania. The type is 51 x 44 mm., thin-shelled, globose, with a short spire and a strongly shouldered body whorl which bears two spiral rows of small, rounded, rather evenly-sized tubercles. The color is pure-white, rather shining, and with a yellow tinge or stain on the outer lip, parietal wall and columella. True umbilicus small, round and deep; false umbilicus chink-like. I have before me a number of other specimens varying in length from 47 to 87 mm., some colored white, others flesh to peach. The shouldering and the development of the tubercles may be stronger or weaker than those in the type. The yellow tint found on the type is usually absent in other specimens. Some shells are quite heavy and may or may not have denticles on the inside of the outer lip.

This *forma* is an extreme variant of *pyrum* connected by a series of gradual intergrades to Iredale's *forma spectabile* and Cotton's *forma*

mawsoni. The latter is merely an immature expression of *spectabile*. It is impossible to assign names to some of the intergrades.

Synonymy—

1872 *Cassis nivea* Brazier, Proc. Zool. Soc. London, for 1872, p. 616, pl. 44, fig. 1 (Macquarie Harbour, west coast of Tasmania. Type in the Aust. Mus. no. C 11498).

1927 *Xenogalea nivea* (Brazier), Iredale, Records Australian Mus., vol. 15, p. 344, pl. 32, fig. 13; 1962, Macpherson and Gabriel, Marine Molluscs of Victoria, Melbourne, p. 151, fig. 180.

1935 *Phalium niveum* (Brazier), Bayer, Zoolog. Mededeel., Leiden, vol. 18, p. 110.

Records—WESTERN AUSTRALIA (south coast): Bremer Bay (West Aust. Mus.). SOUTH AUSTRALIA: Encounter Bay (W. T. Bednall, 1897, ANSP); Beachport (C. F. Kurtze, ANSP). VICTORIA: Portsea; Portland (both Nat. Mus. Vict.); Richmond, near Melbourne (A. F. Kenyon, ANSP). NEW SOUTH WALES: off Eden (Joy Kerslake, coll.). TASMANIA: Macquarie Harbour (Brazier, 1872, p. 616); Kensington (ANSP); Hobart (Joy Kerslake, coll.).

forma spectabile (Iredale, 1929)

(Pl. 13, fig. 12; pl. 153, figs. 3, 4)

Range—Southeast Australia and Tasmania; 50 to 120 fathoms.

Remarks—This name was placed upon a 100 mm., globose, pinkish cream, rather thin-shelled specimen having 3 spiral cords or ridges on the shoulder of the body whorl. The middle cord bears a number of closely-spaced, low, small nodules. The shell was dredged off Montague Island, New South Wales, in 50 to 60 fathoms. This is an uncommon form which connects with *niveum* and *stadiale*, all intergrades existing in specimens before me. Cotton's *mawsoni* differs only in being immature, in having a few more nodules on the main cord of the shoulder, and in having a few elongate nodules in a spiral series just below the main cord. It approaches



Plate 155. New Zealand forms of *Phalium* (*Xenophalium*) *pyrum* (Lamarck). Figs. 1-4, *forma finlayi* (Iredale). Fig. 1, holotype from the Auckland Mus., 86 mm.; figs. 2, 3 from 60-70 fms. off Eastern Otago, 91 mm. Fig. 4, holotype of *matai*

(Powell), Beach Harbour, Breaksea Sound, Fiordland. Fig. 5, *forma powelli* (Finlay), holotype from the Auckland Mus., 40-50 fms. off Whakatane, Bay of Plenty, 73 mm. (photos courtesy of A. W. B. Powell).

niveum (Brazier), and could be considered a synonym of that form just as well.

Measurements (mm.)—

length	width	no. whorls	
80.8	55.5	9	holotype of <i>mawsoni</i> Cotton

Synonymy—

- 1929 *Xenogalea spectabilis* Iredale, Records Australian Mus., vol. 17, no. 4, p. 178, pl. 38, fig. 6 (off Montague Id., New South Wales, 50-60 fms. Type in the Aust. Mus. no. C 57722).
- 1935 *Phalium spectabile* (Iredale), Bayer, Zoolog. Mededeel., Leiden, vol. 18, p. 111.
- 1945 *Xenogalea mawsoni* Cotton, Trans. Roy. Soc. South Australia, vol. 69, pt. 1, p. 168, pl. 12, figs. 1, 2 (120 mi. west of Eucla, Western Australia, 120 fms.). Type in the So. Aust. Mus. no. D 14201.

Records—WESTERN AUSTRALIA: 120 and 90 miles west of Eucla, 75-120 fms. (Cotton's *mawsoni*, 1945, p. 168). SOUTH AUSTRALIA: off Beachport (C. F. Kurtze, ANSP). VICTORIA: Portland; Lorne; Lakes Entrance (all ANSP); Port Fairy; Queenscliff (both Nat. Mus. Vict.). NEW SOUTH WALES: off Forster (Joy Kerslake, coll.); off Montague Id., 50-60 fms. (Iredale, 1929, p. 179). TASMANIA: off Hobart (Joy Kerslake, coll.).

New Zealand Forms

forma *finlayi* (Iredale, 1927)

(Pl. 13, fig. 16; pl. 155)

Range—Off the east coasts of South and North Islands, New Zealand; 15 to 80 fathoms.

Remarks—This name was applied by Iredale to the specimen identified as *stadialis* Hedley by Finlay in 1924 (Trans. Proc. N.Z. Inst., vol. 55, pl. 52, figs. 3a-c) from 20 fathoms between Otago Heads and Waikouaiti, eastern South Island. The shell and other specimens associated with it are about 60 to 90 mm. in length, globose to somewhat elongate, thin-shelled, smooth-shouldered and colored a shining, yellow-brown or with a reddish brown stain. The type is without spiral lines at its base, but other specimens may have various incised lines. The early whorls are cancellate, later ones being mainly spirally incised. Outer lip of type thin and lacking denticles, but thicker specimens have them (*abernethyi* Dell, 1956). Iredale stated that *finlayi* "is easily separable from the Australian species [*stadialis* Hedley] by its more globose form." This is not a specific character in the *pyrum* complex, and I have before me several *finlayi* which are less globose than Australian specimens. The forma *finlayi* does not differ appreciably, and I retain it merely as a courtesy, so that New Zealand workers may refer to it in their ecologic studies. I consider *matai* (Powell, 1952) a dwarf form of *finlayi* with *pyrum* coloration. It was based upon a single live specimen found on intertidal mudflats in southwest South Island. Offshore trawling there would probably bring in other larger specimens.

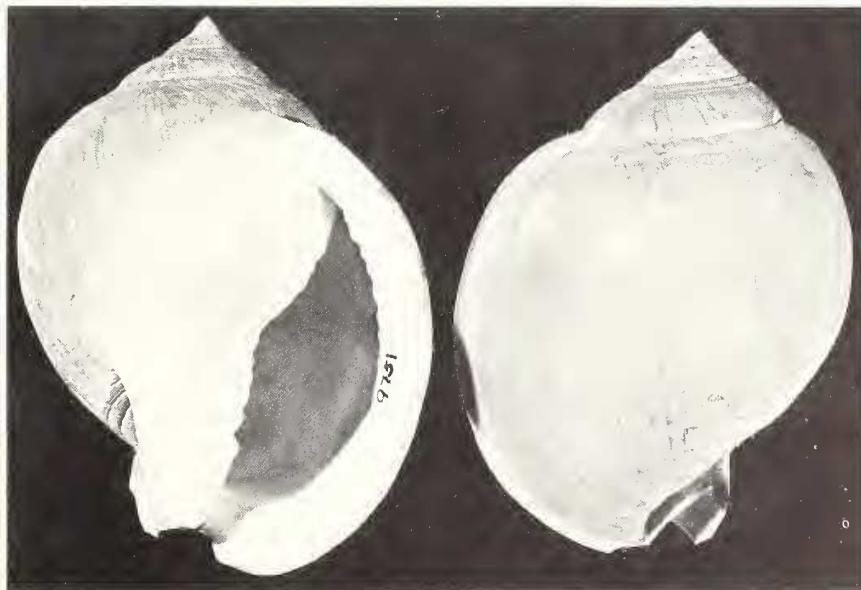


Plate 156. *Phalium* (*Xenophalium*) *pyrum* (Lamarck, 1822) forma *hamiltoni* Powell from 40 fathoms, off Castlepoint, New Zealand. Paratypes, M 9751 of *Xenophalium abernethyi*

Dell, 1956. Left fig.: 64 mm. in length. Other paratypes bear shoulder nodules.

Synonymy—

- 1924 *Cassidea stadialis* Hedley, Finlay, Trans. Proc. New Zealand Inst., vol. 55, p. 525, pl. 52, figs. 3a-c. (20 fms., between Otago Heads and Waikouaiti).
 1927 *Xenogalea finlayi* Iredale, Records Australian Mus., vol. 15, p. 342 (refers to Finlay's figs. 3a-c).
 1952 *Xenophalium* (*Xenogalea*) *matai* Powell, Records Auckland Inst., vol. 4, no. 3, p. 78, pl. 35, fig. 6 (Beach Harbour, Breaksea Sound, Fiordland, New Zealand; intertidal mudflat, alive. Type in the Auckland Mus.).

Records—NEW ZEALAND: 70 fms., off Castlepoint (Dom. Mus.); 50-60 fms., off Otago Heads, Dunedin (Auck. Mus.; ANSP); 15-16 fms., east of Damuru (Dom. Mus.); 80 mi. NNE of Dunedin, 45-75 fms. (John Black, ANSP and USNM).

forma powelli (Finlay, 1928)

(Pl. 155, fig. 5)

Range—East coast of North Island, New Zealand; 40 to 70 fathoms.

Remarks—Related to *finlayi*, but “with a short spire and traces of nodulation on the shoulder; color less tawny, more olive in shade; shell less inflated, especially basally” [and] 73 x 52 mm. Intergrades of *powelli* and other named and unnamed New Zealand forms are before me. The type is figured by Finlay (1926, pl. 20, fig. 64).

Synonymy—

- 1926 *Phalium* n. sp. (*pyrum* auct.), Finlay, Trans. Proc. New Zealand Inst., vol. 57, explanation to plate 20, fig. 64 (40 fms. off Whakatane).

1928 *Xenogalea powelli* Finlay, loc. cit., vol. 59, pt. 2, p. 247, (40-50 fms., off Whakatane, Bay of Plenty).

Records—NEW ZEALAND: NORTH ISLAND: 40-50 fms., off Whakatane, Bay of Plenty (Auck. Mus.); 70 fms., off Castlepoint (Dom. Mus.); off eastern coast of Great Barrier Id.; beach at Maunganui; Opotiki; Waikanae Beach, Cook Strait; 40-50 fms., off Cape Campbell, Marlborough (ex Powell, 1928, p. 639).

forma hamiltoni (Powell, 1928)

(Pl. 156)

Range—East coasts of South and North Islands, New Zealand; 40 to 100 fathoms.

Remarks—Powell (1928, p. 635) characterizes this form as “shell globose, spire low, spire and base striated; suture margined by grooves; entire absence of nodules; no colour pattern.” The type is 71 x 55 mm. and came from 60 fathoms off Cape Campbell, Marlborough, where other intergrading forms are found. Dell's *abernethyi* combines the features of this *forma* and *harrisonae*, and I arbitrarily dispose of it in the synonymy of this *forma*, since the shell is globose and spirally incised. *X. abernethyi* has a more thickened lip and hence weak denticles on the inner edge. Its shoulder may be smooth or with weak nodules, as demonstrated by the paratype series kindly loaned to me.

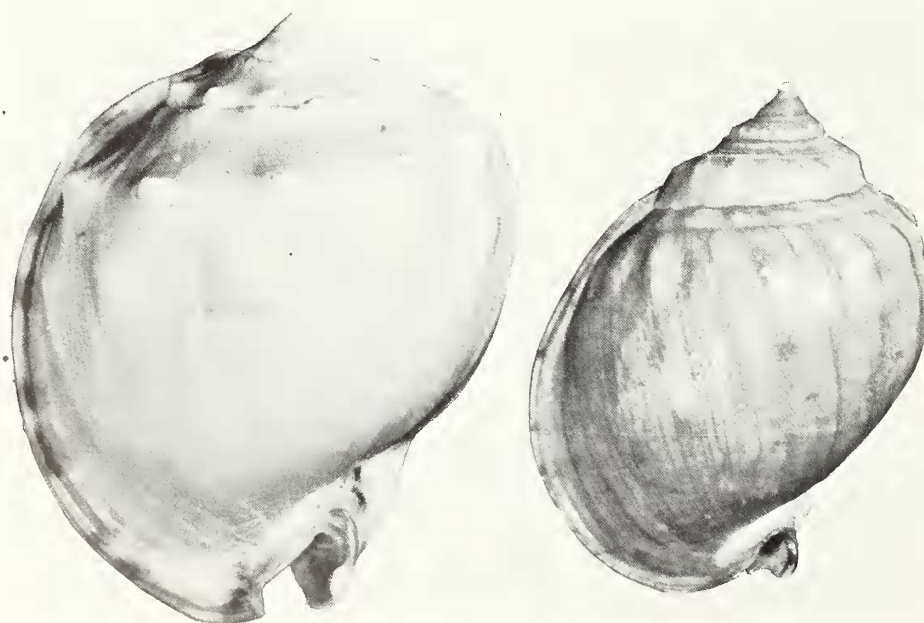


Plate 157. *Phalium pyrum* (Lamarck, 1822). Left: holotype of *Cassis zeylanica* Lamarck. 75.4 mm. [South Africa]. Right:

holotype of *Cassis pyrum* Lamarck. 63.2 mm. [South Australia]. (both in the Mus. Geneva).

Synonymy—

- 1928 *Xenophalium hamiltoni* Powell, Trans. Proc. New Zealand Inst., vol. 59, p. 639, pl. 75, figs. 25, 26 (off Cape Campbell, Marlborough, in about 60 fms.; in Dom. Mus., Wellington).
 1956 *Xenophalium (Xenogalea) abernethyi* Dell, Dominion Museum Bull. no. 18, Wellington, p. 87, pl. 12, figs. 119, 122 (off Castlepoint, east coast Wellington, in 40 fms.; type in Dom. Mus. M9752).

Records—NEW ZEALAND: 60 fms. and 40 fms., off Cape Campbell; 40 fms., off Castlepoint; 65-70 fms., off Wellington, V.U.Z. sta. 44; 100 fms., off Palliser Bay (all Dom. Mus.).

forma harrisonae (Powell, 1928)

(Pl. 13, fig. 10)

Range—Southern South Island and Stewart Island, New Zealand (Recent); Castlecliff, North Island (Pliocene).

Remarks—This is the well-calcified forma from the waters around Stewart Island in the south of New Zealand. Because the shell is thick, denticles on the inside of the outer lip and rugae on the columella are generally moderately developed. The heavy shell is globose, with or without shoulder nodules, and sometimes with a well-developed color pattern. Shells with an extra varix in the last whorl are not infrequent. Spiral incised lines are present below the suture in most but not all specimens. Basal grooves may be absent in some Mason's Bay specimens. Equally heavy shells sometimes occur in more northern localities, but are generally given other names.

Synonymy—

- 1928 *Xenophalium harrisonae* Powell, Trans. and Proc. New Zealand Inst., vol. 59, p. 640, pl. 75, figs. 27, 28 (Mason's Bay, Stewart Island).

Records—NEW ZEALAND: STEWART ISLAND: Mason's Bay (Auck. Mus.; Dom. Mus.; MCZ; ANSP). SOUTH ISLAND: off mouth of Waiiau River, Te Waewae Bay (J. H. Sorensen, Dom. Mus.).

Fossil records—UPPER PLIOCENE: Castlecliff, Wanganui, North Island (Powell, 1928, p. 640).

forma wanganuiense Powell, 1928

Range—Upper Pliocene, North Island, New Zealand.

Remarks—I have not seen this shell, but from its description and illustration it appears to be one of the smooth-shouldered, globose *pyrum* types still found living along the east coast of North Island. It closely resembles *hamiltoni*

and *abernethyi*, and seems more likely to be an element which came in from Australia during the Upper Pliocene (or Pleistocene?), rather than being a descendant of the certainly quite different *fibratum* (Marshall and Murdock, 1920) of the Lower Pliocene.

Synonymy—

- 1928 *Xenophalium wanganuiense* Powell, Transactions New Zealand Institute, vol. 59, p. 637, pl. 76, fig. 36 (Wanganui, Upper Pliocene, Castlecliff, New Zealand, Holotype in N.Z. Geol. Survey).

**Phalium pyrum subspecies
royanum (Iredale, 1914)**

(Pl. 13, fig. 9; pl. 158-159)

Range—New South Wales, Australia, northern New Zealand and the Kermadec Islands.

Remarks—The shells of this subspecies are large for members of the *Xenophalium* group, ranging in length from 4 to 5-1/2 inches. The degree to which the plicae on the columella are developed is quite variable, and denticles on the inside of the lower third of the outer lip may be absent or present. This species is obviously closely related to the *pyrum* group, differing only in the rate at which the whorls descend (causing an acute, raised spire) and the amount of shell matter deposited by the mantle (causing a thick, well-noduled shell). I would not be surprised to learn if shells were found in the Kermadecs and northern New Zealand which had lower spires and fewer nodules. In that event, it might be necessary to consider this as an ecologic warm water form of *pyrum*. Several specimens, all of rather uniform shape, have been brought up in crayfish pots from 10 to 20 fathoms off the Cavalli Islands, Whangaroa, and it certainly seems best to consider *royanum* as a subspecies. *Xenophalium ericanum* Powell from Whangaroa is a smooth-shouldered intergrade. Doubtlessly, other intermediates will be collected in the future. The large size of these shells is probably due to ecologic conditions.

A light-weight form (*forma hedleyi* Iredale, 1927) lives off the coast of New South Wales, and it may be the original source of the New Zealand stock of *royanum*. It is not as heavily noduled as many of the New Zealand specimens, and it bears the color patterns of other Australian forms of *pyrum*, such as *stadiale* Hedley. It is a matter of choice as to whether *hedleyi* should be considered as a subspecies allied to the Australian forms or allied to the *royana* complex

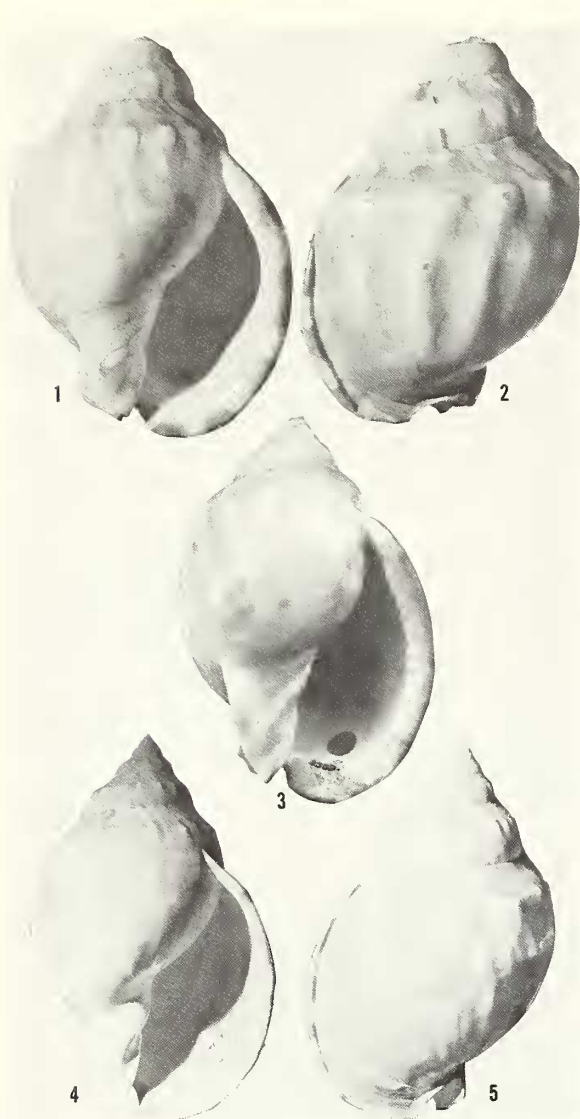


Plate 158. *Phalium* (*Xenophalium*) *pyrum* subspecies *roy-anum* (Iredale, 1914). Top figs., holotype from the Australian Museum, no. C. 63956; Sunday Island, Kermadecs, 131 mm. Center fig., forma *ericanum* (Powell, 1928), holotype from the Auckland Mus., off Berghans Head, New Zealand, 108.5 mm. Bottom figs., forma *hedleyi* (Iredale, 1927), holotype from the Australian Museum, no. C. 53265, 70 fms. off Kiama, N.S.W., Australia, 151 mm.

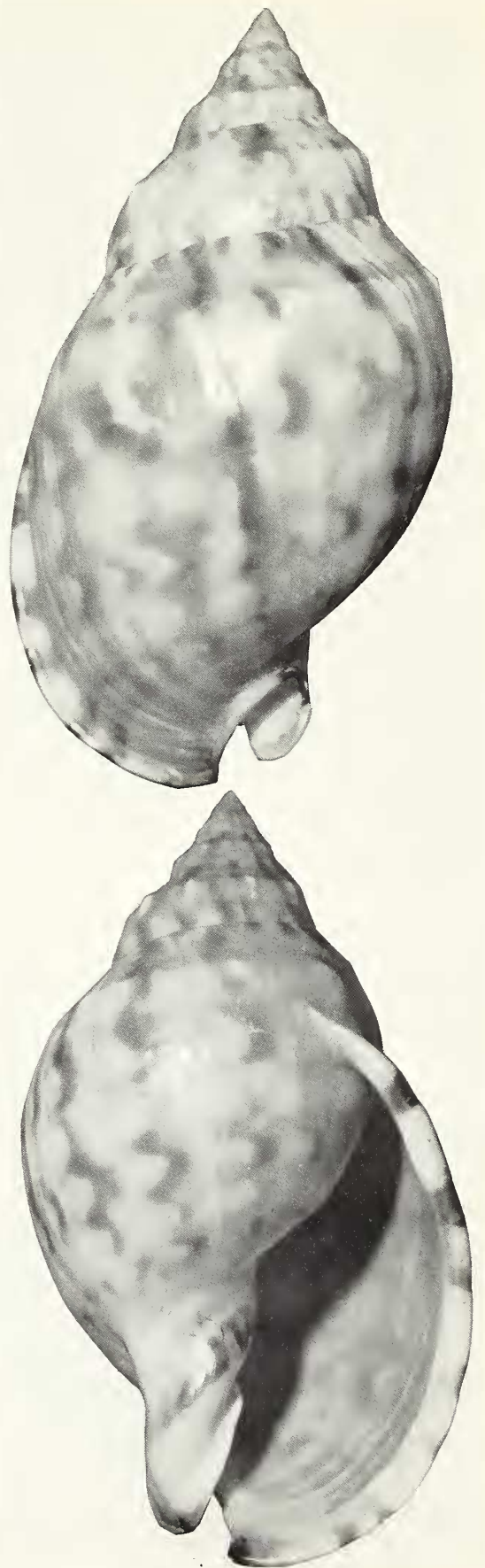


Plate 159. *Phalium* (*Xenophalium*) *pyrum* subspecies *roy-anum* (Iredale, 1914). Port Macquarie, New South Wales, Australia. 135 mm. in length. (courtesy of Kelvin McCallum). This specimen is intermediate between forma *hedleyi* and forma *ericanum*.

which occurs in northern New Zealand and the Kermadecs. I prefer the latter course in order to show the probable close relationship and migratory connections between the New South Wales and New Zealand warm water subspecies.

Description—Adult shell 101 to 135 mm. (4 to 5½ inches) in length, solid, rather heavy and with an elevated spire. Color light-tan with 4 to 5 light-brown spiral bands on the body whorl, and with irregular, axial flames which are especially dominant in the whorls of the spire. Nuclear whorls 2½ smooth and tan. First 2 or 3 postnuclear whorls with numerous microscopic threads and incised lines. The center thread becomes larger and finally develops into a spiral series of small knobs. Shoulder of body whorl with 1 or 2 rows of moderately large nodules, but these may be reduced in size or be absent in some specimens (*forma ericanum*). Outer lip is a thickened, smoothish varix, sometimes denticulate on the inner margin. This varix is crossed by 6 dark-brown to mauve-brown, narrow color bands. True umbilicus slightly to moderately open; false umbilicus sealed. Parietal wall lightly glazed. Columellar shield thick, whitish and rounded. Columella bears 5 to 7 low, short, slanting plicae with the lowest or most anterior one being the largest. Tip of recurved siphonal canal stained with dark brown. Channel behind siphonal canal is moderately shallow and fairly wide. Operculum unknown.

Measurements (mm.)—

length	width	no. whorls	
151.0	84.5	—	Poor Knights Islands, fide Powell, 1967, p. 187
135.0	83.0	—	Kermadecs, fide Powell, 1928, p. 641
131.5	90.0	4+	holotype of <i>royana</i>
122.0	72.0	—	Cavalli Id., fide Powell, 1928, p. 641
110.5	69.0	8+	Flat Id., Cavalli Ids., N.Z.
101.0	61.0	—	Cavalli Ids., fide Powell, 1928, p. 641

Synonymy—

- 1914 *Cassidea royana* Iredale, Proceedings Malacological Society London, vol. 11, p. 179, text fig. (Sunday Island, Kermadec Group).
 1927 *Xenophalium royana* Iredale, Iredale, Records Australian Museum, vol. 15, p. 333; 1928, Powell, Trans. and Proc. New Zealand Inst., vol. 59, p. 641; 1967, Powell, Records Auckland Inst. Mus., vol. 6, no. 3, p. 187.

Types—The type locality is Sunday Island, Kermadec Islands. Collected by Mr. Roy Bell. The holotype of *royana* Iredale, 1914, is in the Australian Museum, no. C 63956, and was not presented to the Canterbury Museum, Christchurch, New Zealand, as Iredale suggested (1914, p. 180).

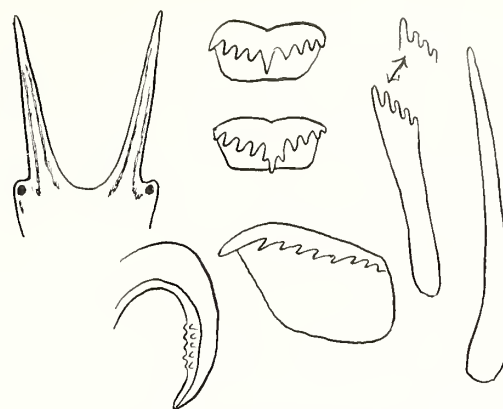


Plate 160. *Phalium (Xenophalium) pyrum* (Lamarek). Head, penis and radulae of New Zealand form from a depth of 40 meters.

Records—NEW ZEALAND: NORTH ISLAND: in crayfish pots, 20 fms., off Cavalli Islands near Whangaroa (W. La Roche, Auckland Mus.); 10 fms., off Flat Id., Cavalli Islands (Boltons, Dominion Museum, N.Z.); living on sand, 150 ft. depth, northwest end of Tawhiti Rahi, Poor Knights Islands (Powell, 1967, p. 187). KERMADEC ISLANDS: (T. F. Cheeseman, 1887, Auckland Mus.); Sunday Id. (Roy Bell, Auckland Mus.). See also *forma ericanum* (Powell, 1928).

forma ericanum (Powell, 1928)

(Pl. 158, fig. 3)

Range—Northeast coast of New Zealand; 25 fathoms.

Remarks—Shells of this form are without the strong nodules of the typical race, *royana*, found nearby. The shell is large and heavy with resulting denticles on the inside of the outer lip. The curious axial growth folds are also found in some specimens of typical *royana*. The supposed specific characters originally recorded for *ericanum* appear at random in most *royana*—like specimens found in this area of New Zealand, and I think it likely that this form and other intergrades will be found in the Kermadecs.

Measurements (mm.)—

length	width	no. whorls	
108.5	62.5	10	holotype of <i>ericanum</i>
98.5	62.0	—	paratype of <i>ericanum</i>

Synonymy—

- 1928 *Xenophalium ericanum* Powell, Trans. and Proc. New Zealand Inst., Wellington, vol. 59, p. 639, pl. 75, fig. 29; 1961, Powell, Shells of New Zealand, ed. 4, p. 93.

Types—The type locality is 25 fathoms off Berghans Head, 8 miles N.E. of Mangonui, N.E. New Zealand. Collected by Mr. Eric Sanderson. The holotype is in the Auckland Museum.

Records—Known only from the type locality.

forma *hedleyi* (Iredale, 1927)

(Pl. 158, figs. 4, 5)

Range—Off New South Wales; 70 fathoms.

Remarks—This rare, large, handsome form is characterized by its elevated spire, its almost absent columellar plicae, and the weakly shouldered whorls which bear small nodules, especially pronounced in the spire. Specimens may reach a length of 5-1/4 inches and be prettily colored with axial, zigzag flames of chestnut brown. The outer lip is not denticulate, although heavier specimens, not found as yet, would undoubtedly possess them. The floating veligers of this form may be capable of reaching northern New Zealand and be contributing to the colonies of *royanum* in the warmer waters of that island. From New South Wales I have seen forms somewhat similar to *hedleyi* which are not as large, have no nodules, but do have a slight shouldering on the body whorl. Gigantism in this group produces columellae with less developed plicae.

Measurements (mm.)—

length	width	no. whorls	
151	92	7+	holotype of <i>hedleyi</i> Iredale
135	79	8+	off Port Macquarie, N.S.W.

Synonymy—

1927 *Xenophalium hedleyi* Iredale, Records Australian Mus., 15, p. 333 (5 mi. off Kiama, New South Wales, in 70 fms. Type in the Aust. Mus. no. C 53265).

Types—The type locality is 70 fathoms, 5 miles off Kiama, New South Wales, Australia (collected by Captain J. W. Smith). The holotype is in the Australian Museum, Sydney, no. C 53265.

Records—NEW SOUTH WALES: 70 fms., off Kiama (type, Aust. Mus.); off Port Macquarie (Kelvin McCallum, coll.); off Cape Everard (Aust. Mus.).

***Phalium pauciruge* (Menke, 1843)**

(Pl. 161)

Range—Limited to southwestern Western Australia.

Remarks—Thanks to the careful work of Iredale, the identity and distinctiveness of this species is now clearly understood. Previously it had been confused by Bednall, Brazier, Verco, and evidently Cotton, with such forms of *pyrum* as *niveum* and *spectabile*. The Western Australian *pauciruge*, when in fresh condition, is

characterized by its very solid, heavy shell, by the 4 or 5 spiral rows of 9 to 14 squarish, orange-yellow blotches on the last whorl, by the small false umbilicus, by a single (rarely double) row of tiny tubercles high on the shoulder, by the usually denticulate inner edge of the outer lip, and by the cream to tan-saffron or yellow interior of the aperture. Dead specimens, more commonly found in collections, have a yellowish cast, have usually lost their spots, and may have a very slick, oily surface. The teeth on the outer lip may be obsolete or 6 to 24 and well-developed. Iredale (1927, p. 346) mentions that an umbilical perforation is present, but I have seen this in only one of 40 specimens examined. The groove at the anterior end of the columellar shield is not always present nor characteristic of this species.

Care should be taken not to confuse this species with a heavy, glistening, spotted form of *pyrum*, sometimes dredged off New South Wales. The eastern dwarf differs in being more globose, with a spiral subsutural line with smaller spots, and without denticulations on the outer lip. Iredale (1929, p. 346) reported a *pauciruge*-like shell from New South Wales, but later (1929, p. 178) named it *spectabile* [a form of *pyrum*].

I examined Salmon's (1948) specimens of "*paucirugis*" and found them to be *pyrum* (Lamarck). However, one of his "*nivea* Brazier" from Australia is a true *pauciruge* (Menke).

Habitat—Dredged in 10 fathoms of water. Dead specimens are sometimes washed up on beaches.

Description—Adult shell 34 to 69 mm. (1-1/4 to 2-3/4 inches) in length, ovate, very solid, glistening white to yellowish, with 4 to 6 spiral series of squarish, light orange-yellow blotches, and smoothish except for a row of minute, low knobs on the shoulder. Nuclear whorls bulimoid, 2-1/2, white, opaque, smooth and shiny. First three postnuclear whorls strongly, but microscopically, decussate with 6 to 10 spiral threads and numerous axial threads. Last 2 or 3 whorls slightly angular at the shoulder where there are numerous small whitish knobs or tubercles. Last third of last whorl usually without these knobs. Spire moderately to well produced, and without former varices. Outer lip with a strong, smooth recurved, brown-to-mauve-spotted varix. Suture minutely impressed. Columella white and with a dozen or so weak or strong spiral lirae which do not extend across the swollen enamel-white, heavy columellar shield. The

latter is rolled back and partially obscures the false umbilicus which is moderately deep. True umbilicus absent or a minute perforation. Inside of aperture light-tan to saffron-yellow. Outer lip with 6 to 24 weakly or strongly developed axial lirae. Color of body whorl whitish to yellowish with 6 spiral rows of squarish orange-yellow blotches, the row just below the suture and the one just above the narrow siphonal gutter being

sometimes obscure or absent. Operculum smooth and light-tan.

Measurements (mm.)—(all from Western Australia)

length	width	no. whorls	
69.0	44.2	6+	Cotteslow, near Perth
65.9	44.3	6+	Swan River, ex Lovell Reeve (Nat. Mus. Vict. F23k99)
61.1	39.6	8	Beagle Island, north of Perth
34.0	23.0	6+	Near Albany

Synonymy—

1843 *Cassis paucitugis* Menke, Molluscorum Novae Hollandiae, Hanover, p. 23, no. 107 (in litore occidentalis [Australia]); 1844, Zeitschr. Malak., p. 60 (Swan River Colony); 1848, Reeve, Conch. Icon., vol. 5, sp. and fig. 19 on pl. 8.

1916 *Cassidea paucirugis* Menke, Hedley, Jour. Roy. Soc. Western Australia, vol. 1, 1916, p. 47 (W. Australia).

1927 *Xenogalea paucirugis* (Menke), Iredale, Records Australian Mus., vol. 15, p. 345, pl. 31, fig. 2 (Western Australia).

Types—I have been unable to locate Menke's type in Germany. However, a specimen in the Zoologisk Museum in Copenhagen, presumably sent to Mörch by Menke, and labelled "*paucirugis* Mke" conforms to our interpretation of this species. The type locality is "in litore occidentalis [Australia]". In 1844, Menke further limited it to Swan River (Perth), Western Australia.

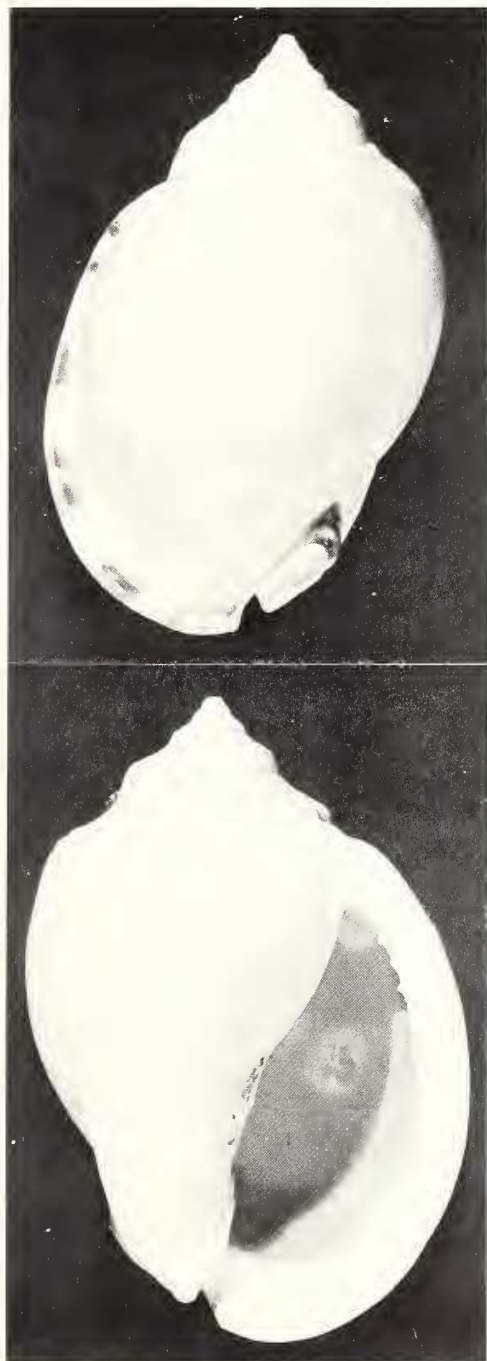


Plate 161. *Phalium* (*Xenophalium*) *pauciruge* (Menke, 1843). Perth, Western Australia. Length of top shell: 58 mm.



Plate 162. Geographical distribution of *Phalium* (*Xenophalium*) *pauciruge* (Menke).

Records—ALL WESTERN AUSTRALIA: Beagle Id., 160 mi. north of Perth (Poole brothers, West. Aust. Mus.); Swanbourne and Cottesloe beaches, Perth (West. Aust. Mus.); dredged off Pt. Gregory, 50 mi. north of Geraldton (A. Whitworth, ANSP); off Kwinana, near Perth (ANSP); Success Bank, Cockburn Sound, near Perth (B. R. Wilson, West. Aust. Mus.); off Rottnest Id., near Perth (Nat. Mus. Victoria); Bremer Bay (West. Aust. Mus.); King George Sound (Nat. Mus. Victoria); Cheyne Bay, 60 mi. east of Albany (B. R. Wilson, West. Aust. Mus.); 1 mi. offshore, Mandurah (E. Nickels, coll. 1964).

Phalium radiatum (Tate, 1889)

Range—Miocene of Murray Desert, New South Wales and South Australia.

Remarks—This species was evidently based upon one specimen which has curious axial ribs. The shell appears to be related to the *pyrum* (Lamarck) group, but it is with some hesitation that I place it in *Xenophalium*. I doubt if it is allied to the Recent *Casmaria erinaceus* [torquata Reeve], as suggested by Tate. The original description reads:

"Shell globosely ovate, spire of moderate length, acuminate, ending in a small pullus [nucleus] of one and a half smooth convex whorls.

"Whorls four, excluding pullus, convex, but interrupted by a broadish concave depression in front of the marginal rib at the anterior suture.

"Posterior whorls ornamented by straight, rather crowded, slender costae, which terminate behind at the ante-sutural depression.

Last whorl ventricose, contracted at the base, and concavely depressed in front of the suture, from which it is separated by a nodosely-crenulated band; ante-sutural zone with three or four spiral threads. Median portion ornamented with angular, slightly elevated, moderately curved costae (about 24); at first slender and crowded, but become stronger and more widely separated with the revolution of the whorl, and are absent in the last-fourth. The costae are interrupted on the shoulder by three inconspicuous angulations; otherwise the surface anterior to the sutural zone is without spiral ornament, except some obscure lines at the base.

"Aperture ovate; outer lip thickened, margin plain, slightly ascending on the penultimate whorl. Columella convex, its surface without granulations, with fine slender revolving plaits; a small tubercle at the posterior angle of the aperture. Length, 23; breadth, 15; length of aperture, 18 mm."

Synonymy—

1889 *Semicassis radiata* Tate, Trans. and Proc. Royal Soc. South Australia, vol. 11, p. 168, pl. 8, fig. 3 (in a well sinking, Murray Desert); 1903, Dennant and Kitson, Records Geol. Survey Victoria, vol. 1, no. 2, p. 34; 1941, Ludbrook, Trans. Royal Soc. South Australia, vol. 65, p. 100; 1958, Ludbrook, *ibid.*, vol. 81, p. 53 (Tareena, N.S.W. and Adelaide, South Australia).

Phalium thomsoni (Brazier, 1875)

(Pl. 13, figs. 14, 15; pls. 163-164)

Range—Southeastern Australia from Bass Straits north to northern New South Wales; northern New Zealand.

Remarks—This distinctive species occurs on the continental shelf in the same areas as the deep-water forms of *pyrum* (i.e., *stadiale* and *spectabile*). In rare instances there may be a superficial resemblance in shell characters, but *thomsoni* is characterized by the left edge of its columellar shield which is strongly and concavely arched (instead of being straight), by the reticulate sculpturing on the early post-nuclear whorls, by the spiral incised lines or weak, rounded, low, wide threads on the base of the shell, and by the 5 fairly broad chestnut spots on the posterior edge of the varix (instead of 5 to 8 spots). *P. thomsoni* is quite variable



Plate 163. *Phalium* (*Xenophalium*) *thomsoni* (Brazier, 1875). New Zealand specimen from 40 fathoms, off Cuvier Island, Bay of Plenty. (courtesy of A. W. B. Powell).



Plate 164. *Phalium* (*Xenophalium*) *thomsoni* (Brazier, 1875). Holotype of the dwarf form, *Xenogalea thomsoni palinodia* Iredale, 1931, in the Australian Museum no. C. 57793 from Sydney Harbour, Australia. 44 mm. in length. (photos courtesy of D. F. McMichael).

in the degree of nodulations on the shoulder. Usually, there are two spiral cords bearing about two dozen rounded nodules, but in some specimens the nodules are more numerous, smaller and axially oblong. A specimen from 60 fathoms off Broken Bay, N.S.W., is almost smooth, except for spiral threads at the shoulder. Large shells, 3 inches in length are lighter in weight and less sculptured. Dwarfed and heavy, well-noduled specimens were given the name *palinodium* (Iredale, 1931).

The nearest relative to *thomsoni* is *whitworthi* Abbott, 1968, from Western Australia. The latter differs in being very strongly corded and in having a higher spire, but otherwise is similar. No morphological or geographical intermediates have as yet been found.

Description—Adult shell from 36 to 88 mm. (about 1½ to 3½ inches) in length, globose, moderately thin- to thick-shelled, spire short, with noded shoulders, and colored with tan-brown and irregular reddish brown spots. Whorls 8 or 9. Nuclear whorls bulimoid, relatively large, 4 smooth, tan or whitish, and followed by finely cancellate postnuclear whorls. Body whorl usually shouldered by 1, 2, or 3 spiral cords which may be finely or coarsely beaded or noded. Base of body whorl bears 4 to 12 spiral, incised lines. True umbilicus open and deep; false umbilicus at the base of the columella is closed or slit-like. Left edge of columella strongly arched. Right or inner edge bears numerous, irregular plicae. Outer lip recurved, usually smooth, but may bear a few to many minute teeth. Tip of siphonal canal bears a very weak, brown splotch. Color spots on body whorl irregular in size and usually occurring in 3 to 5 spiral rows. Operculum and soft parts unknown.

Measurements (mm)—

		no.	
length	width	whorls	
88.0	68.2	8	large; New South Wales (J. Kerslake)
70.0	49.6	8	average; off Eden, New South Wales
56.0	39.0	8	holotype of <i>thomsoni</i> Brazier
44.0	35.0	—	holotype of <i>palinodia</i> Iredale
36.2	25.3	7	small; southern New South Wales

Synonymy—

- 1875 *Cassis* (*Casmaria*) *thomsoni* Brazier, Proc. Linn. Soc. New South Wales, vol. 1, p. 8 (45 fms., 5 mi. due east of Sydney Heads, Australia, "Challenger". Type in Aust. Mus. no. C 111612).
- 1889 *Cassis thomsoni* Brazier, Whitelegge, Journ. Proc. Roy Soc. New South Wales, vol. 23, p. 257.
- 1902 *Cassidea pyrum* var. *thomsoni* Brazier, Hedley, Mem. Australian Mus., vol. 4, p. 341, pl. 35, figs. 2, 3.
- 1927 *Xenogalea thomsoni* (Brazier), Iredale, Records Australian Mus., vol. 15, p. 342, pl. 32, fig. 6, 7.
- 1931 *Xenogalea thomsoni palinodia* Iredale, Records Australian Mus., vol. 18, p. 215 (Sydney Harbour, Australia. Type in Aust. Mus. no. C 57793).
- 1964 *Xenophalium* (*Xenogalea*) *thomsoni* (Brazier), Powell, Records Auckland Inst. and Mus., vol. 6, no. 1, p. 13, figs. 4, 5.

Records—TASMANIA (Northern part, fide Macpherson and Gabriel, 1962, p. 149). VICTORIA: off Cape Everard (Nat. Mus. Vict.). NEW SOUTH WALES: 25-100 fms., off Eden (Neil F. Buckland, ANSP); off Montague Id. (Aust. Mus.); 30-70 fms., off Cape Green (Aust. Mus.); off Ulladulla (J. Kerslake, coll.); 60 fms., off Botany Bay (Nat. Mus. Vict.); Sydney Harbour and Broken Bay (Aust. Mus.); 30 fms., off Port Stephens (A. D'Attilio, coll.); Forster (Joy Kerslake, coll.). QUEENSLAND: 60-100 fms., off Moreton Bay, near Brisbane (Joy Kerslake, ANSP). NEW ZEALAND: (all fide A. W. B. Powell, 1964, p. 13.) 40 fms., off Cuvier Id., Bay of Plenty (A. and E. Turner, coll.); 30 mi. north of Mangonui; 20-29 fms., off Stephenson Id., Whangaroa; Marsden Point, Whangarei Heads.

Fossil records—None known.

Phalium whitworthi new species, Abbott

(Pls. 165-168)

Range—Known only from off Western Australia.

Remarks—In recent years fishermen have been bringing to light a distinctive cassid which appears to be undescribed. I take pleasure in naming it after Arch R. Whitworth of Geraldton, who first sent me specimens in 1962. *P. whitworthi* is related to *thomsoni* (Brazier) of eastern Australia, and subsequent collecting in southern Australia might possibly reveal the presence of intergrades. *P. whitworthi* is characterized by 12 to 14 very strong, squarish, beaded, spiral cords on the body whorl. As in *thomsoni*, the umbilical side of the columella is strongly and concavely arched. The two species are similar in range of coloration and in the variability of

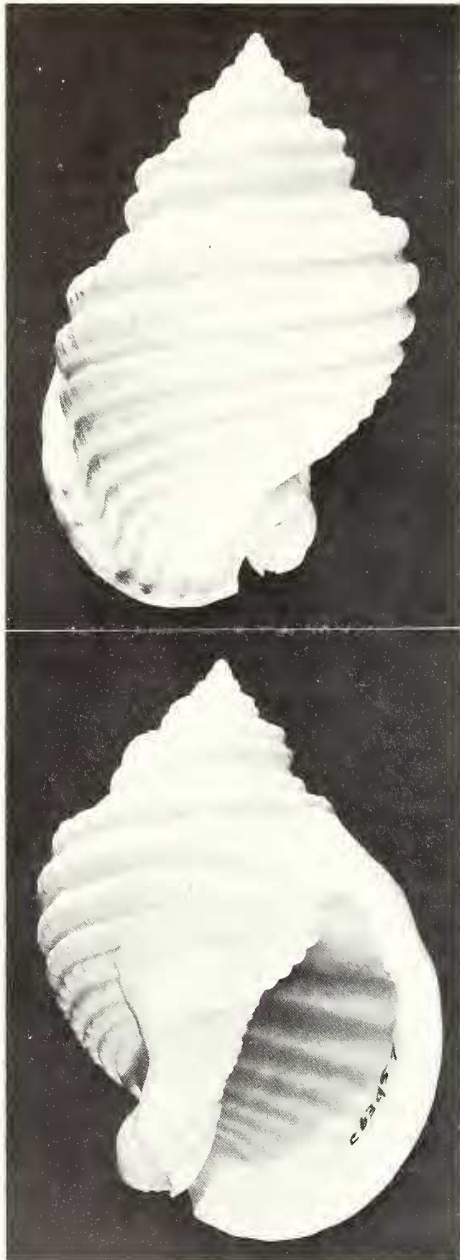


Plate 165. Holotype of *Phalium (Xenophalium) whitworthi* Abbott new species from Abrolhos Islands, Western Australia. Australian Museum no. C. 63957.

the small teeth on the glossy, reflexed outer lip. One of 7 specimens seen has a former varix on the penultimate whorl.

Description—Adult shell from 60 to 83 mm. (about 2-1/3 to 3 inches) in length, solid, globose, strongly corded, tan with sparse, brown spots, and with a deep umbilicus. Whorls 8. Nuclear whorls 4, bulimoid, smoothish, and yellowish white. First 2 or 3 postnuclear whorls cancelled by axially slanting threads and numerous,



Plate 166. Operculum of *Phalium (Xenophalium) whitworthi* Abbott, new species. 20 mm. Western Australia. Paratype.

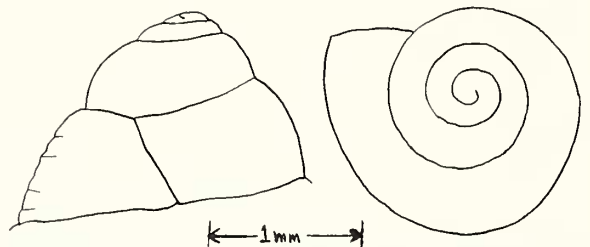


Plate 167. Nuclear whorls of *Phalium (Xenophalium) whitworthi* Abbott new species. Recent; Western Australia.

irregular spiral threads. The whorls in the spire bear 4 to 5 strong, square, spiral cords. Body whorl with 12 to 14 cords which bear numerous, axially elongate, whitish beads. Color of shell tan to cream with a few, small, irregularly-placed, chestnut to reddish brown spots. Posterior edge of reflected varix bears 5 or 6 single or paired, brown spots. Tip of siphonal canal with a small bar of brown. True umbilicus round and deep; false umbilicus open. Interior of aperture white and channelled by the ribs on the last whorl. Outer lip undulating or marked by about 15 to 20 small teeth, some of which may be clumped in pairs. Columella rugose, white, glossy, and concavely arched on its left edge next to the umbilicus. Operculum fan-shaped and strongly, radially sculptured.

Measurements (mm.)—

length	width	no.	
		length	whorls
83.0	56.2	9	paratype; Jack Fearnly collection.
81.0	56.0	9	holotype, Aust. Mus. C 63957
77.6	51.0	9	paratype, near West Wallaby Id.
68.1	43.5	8	paratype, Beagle Id. (W. Aust. Mus.)
60.0	43.1	8	paratype, North Id. (ANSP 272396)

Types—The type locality is the Abrolhos Islands, Western Australia. The holotype has been deposited in the Australian Museum, rather than the Academy of Natural Sciences, since this is an Australian species. Paratypes are in

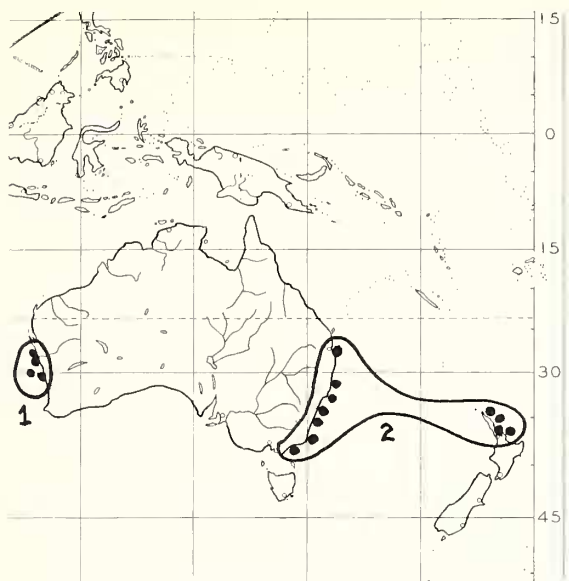


Plate 168. Geographical distribution of *Phalium* (*Xenophalium*) *whitworthi* Abbott (fig. 1 in Western Australia) and *Phalium* (*Xenophalium*) *thomsoni* (Brazier) in eastern Australia and northern New Zealand, fig. 2.

ANSP no. 272396 and the Western Australian Museum no. 159-62.

Records—WESTERN AUSTRALIA: 20-40 fms., off Beagle Island (Poole Brothers, West. Aust. Mus.); crayfish pots, North Island, Abrolhos Ids. (A. R. Whitworth, ANSP); crayfish pots, near West Wallaby Id., Abrolhos Ids. (A. Kalnins); near Geraldton (West. Aust. Mus. no. 163-62). All paratypes.

Phalium inornatum (Pilsbry, 1895)

(Pl. 13, fig. 6; pl. 169)

Range—Central Japan to the South China Sea.

Remarks—This species is moderately common off the coasts of Honshu Island in depths from 20 to 50 fathoms, but to the south, in the China Sea, it has been collected in 170 fathoms. It is reminiscent of *Phalium* (*Semicassis*) *bituberculatum* (von Martens) off the East African coast in that it has a tendency toward beading on the shoulder and a slight tendency toward pustules on the columellar shield. In general shape, coloration and parietal characters it resembles some Australian species, such as *pyrum* (Lamarck). In Japan, it may be confused with *glabratum bulla* Habe, 1961, but *inornatum*'s color spots, smoother columellar shield, the finely noded shoulder, and the brown-tipped columella will separate it from *bulla*. *Phalium inornatum* is variable in shape (sometimes being smooth-shouldered), and color (yellowish, rosy-brown or whitish), and in the degree to which the true umbilicus is open. The outer lip has a few dark-brown, usually wide bands, while in *bulla* they

are numerous, evenly-spaced and light mauve-brown.

Description—Adult shell oblong, solid, with a conic, somewhat elevated spire, shouldered above, weakly umbilicate, with a weakly dentate outer lip, and colored cream with weak, yellowish brown spots. Nuclear whorls 3-1/2, bulimoid, glossy, and white. Post-nuclear whorls in spire shouldered and bearing numerous, rough, spiral threads, the largest sometimes bearing numerous

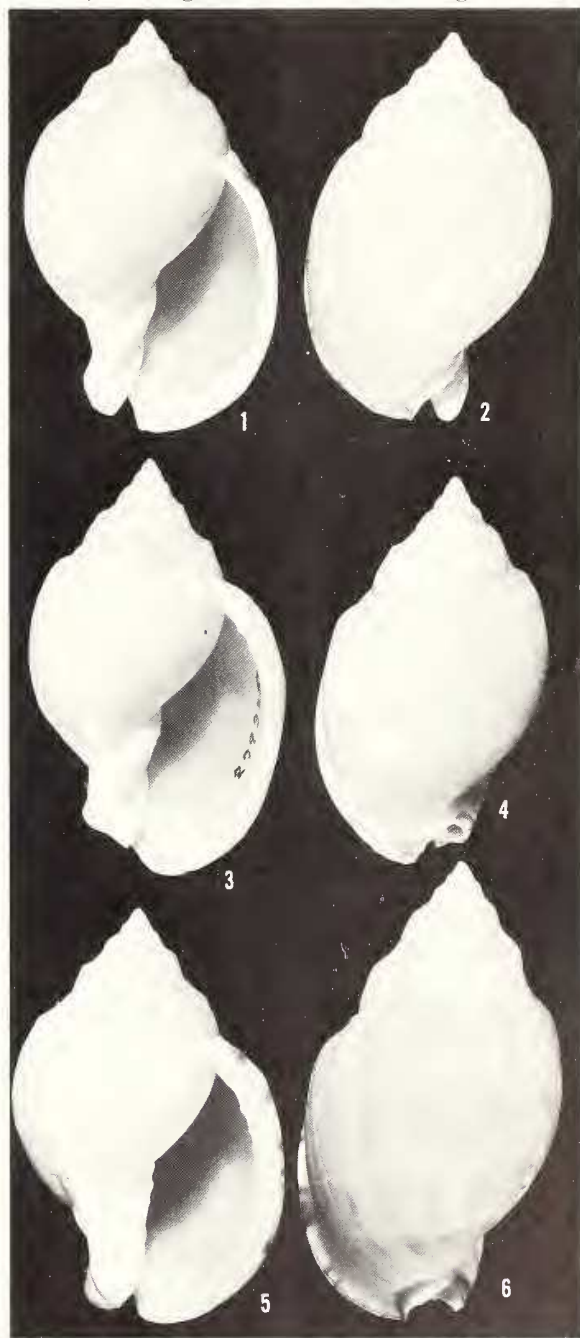


Plate 169. *Phalium* (*Xenophalium*) *inornatum* (Pilsbry, 1895). Figs. 1, 2, smooth form, off Kyushu Island, Japan. 51.3 mm. Figs. 3, 4, noded form, off Kyushu Island, Japan. 52.5 mm. Figs. 5, 6, both off Tosa, Japan, 48 and 60 mm.

small nodules. Body whorl smooth, except for the finely noded shoulder and for 5 to 8 fine, wavy, incised lines at the base. Color cream to yellowish with 5 or 6 spiral rows of indistinct, irregular, small yellowish brown blotches. Outer lip thick, glossy, reflected and with 5 broad, broken bands of dark-brown. Parietal wall lightly glazed. Columella shield smoothish, except for a swollen ridge in the middle, a raised spiral ridge at the base, and sometimes 3 to 7 small, obscure pustules on the lower half. Outer lip smooth or with a few poorly developed teeth. True umbilicus moderately open or sometimes almost sealed. False umbilicus usually sealed. Tip of siphonal canal black-brown. A fine raised thread runs back from the edge of the siphonal canal into the true umbilicus. Operculum light tan, thin, fan-shaped, with weak radial indentations and with numerous, fine, concentric growth lines. Soft parts unknown.

Measurements (mm.)—

length	width	no. whorls	
65.0	40.0	—	holotype, fide Pilsbry, 1895
56.0	32.6	8	large; off Tosa, Japan
51.6	34.6	8	average; Wakayama, Japan
41.3	26.2	8	small; Ise Bay, Mie Pref.

Synonymy—

- 1895 *Cassis achatina* var. *inornata* Pilsbry, 1895, Catalogue of the Marine Mollusks of Japan, Detroit, p. 49 (Japan).
 ?1909 *Cassis achatina pyrum* Lam., Iwakawa, Cat. Jap. Moll. Tokyo Imperial Mus., pt. 1, p. 66 (Misaki). ?
 1935 *Phalium (Xenogalea) labiatum* var. *inornata* Pilsbry, Bayer, Zoolog. Mededeel., vol. 18, p. 109 (Kii, Japan).
 1947 *Semicassis (Xenogalea) inornata* (Pilsbry), Furukawa and Kubota, A Catalogue of Moll. Shells from Fukui Pref., ed. 2, p. 12, no. 259; 1961, Oyama, The Molluscan Shells, Resources Exploitation Institute, Tokyo, vol. 5, *Semicassis* plate I, fig. 4-6.
 1961 *Xenogalea inornata* (Pilsbry), Habe, Coloured Illustrations of the Shells of Japan, Osaka, vol. 2, p. 44, pl. 21, fig. 12 (50 to 100 meters, Japan).

Records—JAPAN: 20 fms. off Tosa, Shikoku Id., Ise Bay, Mie Prefecture, Honshu Id.; Wakayama, Honshu Id.; Tokyo Bay, Honshu Id.; off Kyushu Id.; Kii; Sagami Bay, Honshu Id. (all A. R. Cahn coll'n., ANSP). *CHINA:* 170 fms., coral sand, northeast of Pratas Id., South China Sea. Albatross Station 5306 (USNM).

**?*Phalium gradiferum*
(Cossmann and Pissarro, 1909)**

*Range—*Lower Eocene of Sind, India (Ranikot series).

*Remarks—**P. gradiferum* appears to be a juvenile and imperfectly preserved form of *Xenophalium*, possibly related to *P. phillipsi* d'Archiac

and Haime. The latter was reported by Cossmann and Pissarro (1909, p. 37) from a nearby locality in the Ranikot series. The shell is peculiar in having a narrow but deep channel at the suture. Vredenburg (1928, p. 41) proposed a new section name, *Eocasmaria*, for this species which I have synonymized with *Xenophalium*. The original description of the species reads:

"Small (22 mm. in length), short, globose; spire feebly prominent, forming successive steps, approximately conical in general outline; four convex spire-whorls separated by deep channelled sutures. The sutures are surrounded by a projecting thread followed by a narrow, slightly excavated band, which becomes more accentuated as the shell increases in size. Body-whorl very large, constituting almost the whole shell, partly spherical, with a rounded base which is excavated only at the neck where it bears a series of concentric threads rendered subgranular by the intersection of lines of growth interrupted against the screw-like keel formed by the successive growths of the basal notch revolving round the neck in a flattened zone. Aperture broad, oval, deeply notched anteriorly; outer lip feebly slanting, without a thickened rim; columella excavated, with a few wrinkles behind the spiral keel limiting the swelling that surrounds the neck; columellar margin constituting a thick callus posteriorly, indistinct at the level of the wrinkles."

Synonymy—

- 1909 *Cassidea (Casmaria) gradifera* Cossmann and Pissarro, Memoirs Geol. Survey India, Palaeontologia Indica, new ser. vol. 3, no. 1, p. 38, pl. 6, fig. 8-10 (lowermost zone of Upper Ranikot, underscarp of Jakhmari peak, Sind, India; Lower Eocene).
 1928 *Cassidea (Semicassis) (section Eocasmaria) gradifera* C. and P., Vredenburg, ibid., new ser., vol. 10, no. 4, p. 41.

***Phalium moniliferum* (Sowerby, 1846)**

*Range—*Tertiary of Chile.

*Remarks—*This species resembles the thick, knobbed, living *Phalium* of South Africa. I have only seen the type, which is in the British Museum Department of Paleontology no. G 26364. It measures 38.7 mm. in length and 28.0 in width.

Synonymy—

- 1846 *Cassis monilifer* Sowerby, 1846, in Darwin's Geological Observations on South America, vol. 3, appendix, p. 260, pl. 4, fig. 65 (Navidad, Chile).
 1887 *Cassis monilifera* Sowerby, Philippi, Die Tertiären und Quartären Versteinerungen Chiles, Leipzig, p. 68, pl. 8, fig. 1 (Lebu and Llancahue, Chile; Tertiary).

Phalium labiatum (Perry, 1811)

This cool-water species has one of the most interesting distributions of all the cassids, for it consists of a series of races ringing the continents of the Southern Hemisphere. Its most isolated and most uniform subspecies, *iheringi* (Carcelles), occurs in northern Argentina, Uruguay and southern Brazil. In South Africa, it appears to be radically polymorphic, probably due to constant hybridization with *Phalium pyrum* (Lamarck). The probable hybrid or ex-

treme ecologic form in South Africa received the name of *zeylanicum* (Lamarck). In Australia and New Zealand, the typical subspecies, *labiatum* (Perry), occasionally exhibits characters which strongly suggest hybridization with the *pyrum* of those waters. The Australian "hybrid" received the name *insperatum* (Iredale), the New Zealand one, *collacteum* (Finlay).

A profound influence on the morphology of the shell by ecologic conditions may be the alternate explanation for this puzzling array of forms. A specimen I have illustrated here from

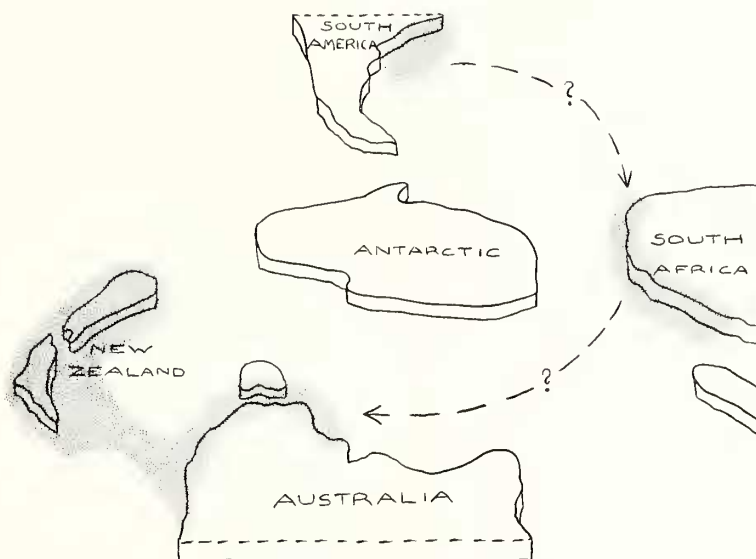


Plate 170. Circumpolar distribution of *Phalium* (*Xenophalium*) *labiatum* (Perry) showing direction of hypothetical

migration, by means of ocean currents, of free-swimming larvae.

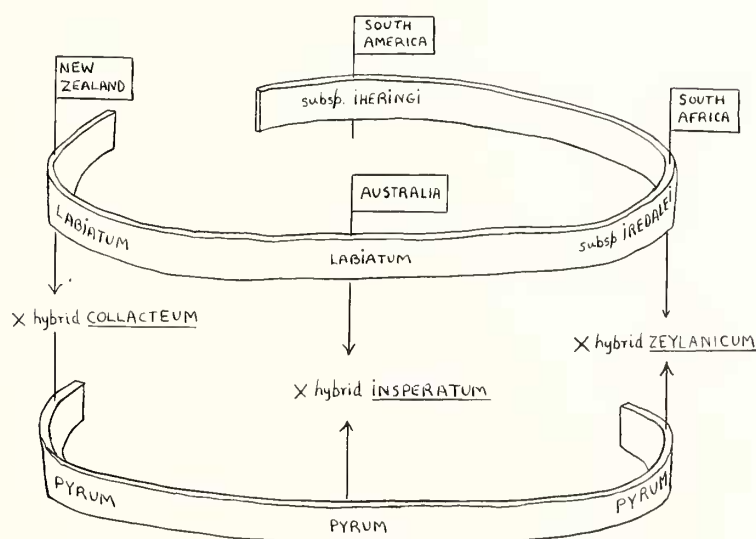


Plate 171. Circumpolar distribution of two species of cold-water *Phalium* (*Xenophalium*) showing the hypothetical origin of hybrid forms in New Zealand (*labiatum* × *pyrum* = *col-*

lacteum) and in South Africa (*labiatum iredalei* × *pyrum* = *zeylanicum*).

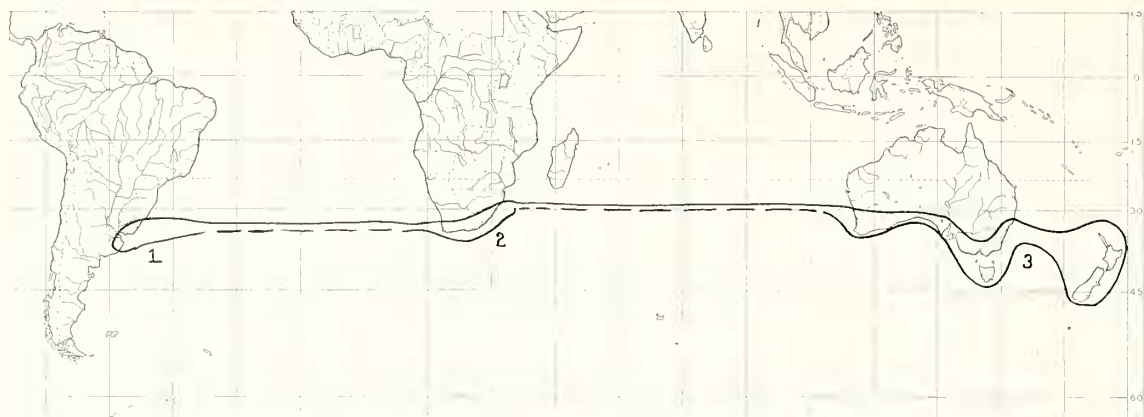


Plate 172. World distribution of *Phalium labiatum* (Perry). 1, subspecies *iheringi* (Carcelles, 1953); 2, subspecies *iredalei* (Bayer); 3, typical subspecies *labiatum* (Perry).

New Zealand shows typical “*collecteum*” characters in the first 5 whorls, but in the last whorl there is seen a sudden change to typical *labiatum* characters. These changes may possibly be associated with the temperature, motion and depth of the water. That some genetic control exists is suggested by the purely *labiatum*-like qualities of South American shells where no specimens of *pyrum* are known to exist. In the absence of rearing experiments under various ecologic conditions, I am treating this complex in the conventional manner in order to keep the nomenclature relatively simple. I have observed that there is no sexual polymorphism, at least in the South African forms.

The most significant difference between the South African and Australian-New Zealand subspecies is the presence, in the latter, of about 3 to 7 very weak lirae on the inner central area of the columella. The lirae are absent or very slightly developed in South African specimens. This difference also exists in the forms of *pyrum*, again the South African representative having a smooth central columella. This geographical peculiarity in one character is expressed in other characters in certain Australian species (see remarks under *Phalium* (*Semicassis*) *whitworthi*, *thomsoni* and *glabratum* subspecies *angasi*).

Although there are some specimens of *labiatum* from each area that are difficult to distinguish from each other, there are subtle differences and locally dominant characters which I believe justify recognizing three geographical subspecies:

Australia-New Zealand: *labiatum* subspecies *labiatum* (Perry, 1811). Small plicae usually present on columella's inner edge. Parietal

wall (when not covered with white glaze) has axially coalescing brown blotches and arrows. Channel behind siphonal canal usually narrow. Shell of noduled form, not very heavy, and with 1, rarely 2, rows of weak nodules on the shoulder. Small brown spots prominent just below the sutures, especially in the spire. Nuclear whorls usually pink or tan, rarely white.

South America: *labiatum* subspecies *iheringi* (Carcelles, 1953). Small plicae usually present on columella's inner edge. Parietal wall has 3 spiral rows of large, arrow-shaped brown blotches. Channel behind siphonal canal usually broad. Shell of noduled form, not very heavy, and with 1 row of nodules on the shoulder. Brown spots below suture large and diffused. Nuclear whorls always (?) white.

South Africa: *labiatum* subspecies *iredalei* (Bayer, 1935). Small plicae usually absent on columella's inner edge. Parietal wall (when not covered with thick, white glaze) has 3 or 4 poorly or strongly defined rows of brown spots or arrow-shaped blotches. Channel behind siphonal canal usually broad in the heavy noduled “hybrid” form, and usually somewhat narrow in the typical, smooth, light-weight form. Shell of noduled form, usually very heavy, and with 1 to 3 rows of heavy, pointed nodules on the shoulder. Brown spots below suture moderately large and weakly colored. Nuclear whorls pink, tan or white.

In all races the true umbilicus may be moderately open and deep or almost closed. The false umbilicus may be sealed or minutely indented or slit-like. All races vary in shape from oblong-ovoid to somewhat globose. The outer lip may be smooth or more commonly with up to

24 small teeth. The Australian specimens are usually rather heavily denticulate, especially on the lower half of the lip. The operculum is horny, thin, light-brown, semi-circular, with faint radial indentations, with very fine, concentric growth lines, about $\frac{1}{3}$ the length of the aperture.

**Phalium labiatum subspecies
labiatum (Perry, 1811)**

(Pl. 13, fig. 17-21)

Range—Portland, Victoria, to southern Queensland; northern New Zealand; Norfolk Island.

Remarks—The typical subspecies of *labiatum* is quite common in New South Wales, but is uncommon to rare elsewhere in its range. Evidently the waters of Tasmania and southern New Zealand are too cold for its survival, and most of Queensland is too warm. It has evidently come northward from New Zealand to Norfolk Island, but, to date, has not been recorded from the Kermadecs. New Zealand specimens do not differ significantly from those living in New South Wales, and they are probably very recent arrivals. Both the smooth shouldered form and that with one or two rows of weak nodules (forms *insperatum* Iredale, 1927 and *collacteum* Finlay, 1928) live in the same places. The shell is variable in coloration, sculpture and shape. I have seen two specimens which for the first 6 whorls were pale in color and with shoulder nodules, but which turned into the darkly blotched, smooth-shouldered form in the last whorl. There is no geographical cline present in these various ecologic forms, and statements by various authors that globosity, thickness of shell, development of columellar teeth, color patterns, etc. are significant characters in this species are not to be taken seriously. The variability of *labiatum* in New Zealand led Powell (1928, pp. 631-633) to interpret some shells as being the result of hybridization of *labiatum* and *insperatum*. Considering the variability found within a single specimen, and allowing a normal amount of variability in the radula, I think that hybridization between two such "species" is not a reasonable explanation. I would, however, not overlook the possibility that there has been some retrogression or hybridizing with the local *pyrum*.

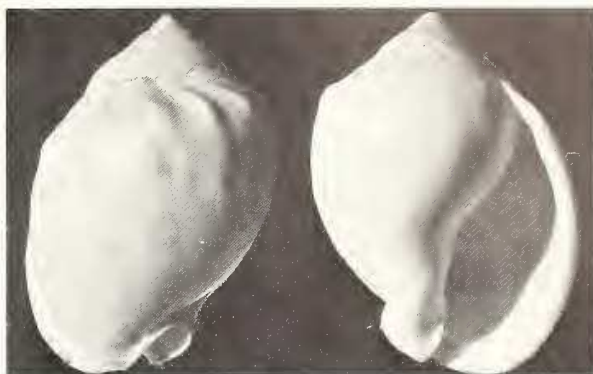


Plate 173. *Phalium* (*Xenophalium*) *labiatum labiatum* (Perry, 1811). Syntypes (cotypes) of *Xenogalea insperata* Iredale in the Australian Museum no. C. 53270 from Port Jackson, New South Wales, Australia. (photos courtesy of D. F. McMichael).

Description—Description and comparative remarks about this subspecies appear above. Adults vary from $1\frac{1}{3}$ to $3\frac{1}{4}$ inches in length.

Habitat—*S. labiatum* occurs from the littoral zone below the low tide mark to depths of about 50 fathoms. It is occasionally washed up onto beaches.

Measurements (mm.)—

		no.	
length	width	whorls	
82.6	52.1	7+	large; Western Point, Victoria
81.4	52.0	8+	large; Hauraki Gulf, New Zealand
69.0	48.0	—	type of <i>collactea</i> Finlay
56.0	41.0	—	type of <i>insperata</i> Iredale
54.5	37.2	7	lectotype of <i>achatina</i> Lamarck
51.8	32.0	7+	elongate; Collaroy Beach, N.S.W.
42.8	30.0	7+	globose; Collaroy Beach, N.S.W.
34.0	24.0	6+	small; Wooli, New South Wales

Synonymy—

- 1811 *Cassidea labiata* Perry, Conchology, London, pl. 34, fig. 1 ("South Seas").
- 1816 *Cassis achatina* Lamarck, Le Liste, Paris, p. 3, Tableau Encyclopédique et Méthodique, vol. 1 (pt. 23), pl. 407, figs. 1a, b. (Nova Holl.); 1822, Anim. sans Vert., vol. 7, p. 226 ("les mers de la Nouvelle Hollande"); 1835, Kiener, Coquilles Vivantes, Cassis, p. 37, pl. 13, fig. 24.
- 1840 *Cassidea achatina* [Lamarck], Swainson, Treatise Malacology, London, p. 299.
- 1848 *Cassis achatina* Lamarck, Reeve, Conch. Icon., vol. 6, Cassis, pl. 10, figs. 28a, b. (South African locality erroneous; both shells are Australian).
- 1873 *Semicassis* (*Casmaria*) *achatina* Lam., Brazier, Proc. Zool. Soc. London, for 1872, p. 838, no. 5 (Port Jackson, found under stones; Merimbula, etc.).
- 1902 *Cassidea labiata* Perry, Hedley, Proc. Linn. Soc. New South Wales, vol. 27, p. 27.
- 1918 *Phalium labiatum* Perry, Hedley, Jour. Roy. Soc. New South Wales, vol. 51, p. M.67.
- 1927 *Xenogalea labiata* (Perry), Iredale, Records Australian Mus. vol. 15, pp. 347-349, pl. 31, fig. 1; 1962, Macpherson and Gabriel, Marine Molluscs of Victoria, Melbourne, p. 149, fig. 178.

- 1927 *Xenogalea insperata* Iredale, *ibid.*, p. 349, pl. 31, fig. 8 (type locality here designated: Port Jackson, New South Wales).
- 1928 *Xenogalea collectea* Finlay, Trans. and Proc. New Zealand Inst. Wellington, vol. 59, p. 246 (Opotiki, Bay of Plenty, New Zealand). Refers to *ibid.*, vol. 57, pl. 20, figs. 62, 63 (1926).
- 1928 *Xenophalium labiatum* (Perry), Powell, Trans. and Proc. New Zealand Inst., Wellington, vol. 59, p. 640, figs. 15-17.
- 1928 *Xenophalium insperatum* (Iredale), Powell, *ibid.*, p. 641, fig. 19.
- 1945 *Xenogalea inseparata* Iredale, Cotton, Trans. Royal Soc. South Australia, vol. 69, no. 2, p. 251 (error for *insperata* Iredale).

Types—Perry's type of *labiatum* is probably lost. Among Lamarck's specimens of *achatinum* in the Museum de Genève is one which was figured by Kiener (1835, pl. 13, fig. 24). We designate it as the lectotype of *achatinum* Lamarck, 1816. It measures 54.5 x 37.2 mm. and has 7 whorls. The type locality is Australia. The type of *insperatum* Iredale from Port Jackson, New South Wales, is in the Australian Museum, Sydney, no. C.53270. The type of *collecteum* Finlay is in the Auckland Institute and Museum and the type locality is Opotiki, Bay of Plenty, New Zealand.

Records—AUSTRALIA: VICTORIA: Portland (Miss Niven, 1916); San Remo; Western Port (all Nat. Mus. Vict.). NEW SOUTH WALES: Wonboyn Beach, Disaster Bay (Joy Kerslake, coll'n.); 50 fms., off Eden (Neil F. Buckland, ANSP); La Perouse; Vacluse; Bottle and Glass Rocks; Collaroy; Manly; Narrabeen; all near Sydney (all ANSP); Long Reef, near Sydney, (R. T. Abbott, MCZ); off Port Stephens (G. Thornley, ANSP); Port Macquarie (B. Kaspiew, ANSP); Nambucca Heads (Nat. Mus. Vict.); off Tweed Heads (ANSP); off Clarence River (Nat. Mus. Vict.). QUEENSLAND: Southport (Nat. Mus. Vict.); Caloundra (Aust. Mus.). NEW ZEALAND: Ahipara, Ninety Mile Beach; Opotiki, Bay of Plenty (both A. W. B. Powell, ANSP); Kemp's Beach, Pakiri, Jauraki Gulf (V. Orr, 1961, ANSP); Mt. Maunganui, Bay of Plenty (Dom. Mus. N.Z.); Omaha, Hauraki Gulf (Dom. Mus. N.Z.); Smugglers Bay, Whangarei Heads; Tauranga Harbour; Tryphena, Great Barrier Island, 10 fms.; Muriwai Beach, West Coast (all Powell, 1928, p. 641). NORFOLK ISLAND: (Iredale, 1927, p. 348).



Plate 174. Operculum of *Phalium* (*Xenophalium*) *labiatum* subspecies *iredalei* (Bayer, 1935). South Africa. 20 mm.

Phalium labiatum subspecies *iredalei* (Bayer, 1935)

(Pl. 13, figs. 1-5)

Range—Cape Province to Natal, South Africa.

Remarks—Typical specimens of this smooth-shouldered, darkly-colored, rather small subspecies differ from typical *labiatum labiatum* (Perry) of Australia in lacking the small spiral lirae or plicae on the inner central part of the columella. Atypical forms (*forma zeylanicum* Lamarck) are very heavy, with strong nodules on the shoulder, and may have bluish white spots on the body whorl.

In South Africa this subspecies is extraordinarily variable and, in my opinion, is an example of introgression or hybridization with the probably deeper water and rarer *Phalium pyrum* (Lamarck). This hybrid swarm seems to occur along the entire South African shores from Cape Town to Durban, Natal. Numerous intergrades are found at most localities which connect the light-weight, smooth *iredalei* and the larger, heavier, knobbed hybrid *iredalei* X *pyrum* (Lamarck's *zeylanica* and von Martens' *intercedens*). Nothing is known about the actual habitats of these forms, although the few authenticated lots indicate that *pyrum* and some heavy forms are found well offshore in 40 to 50 fathoms. Both forms are thrown up on many South African beaches in rather large quantities, but do not live in the intertidal zone so far as I know. Barnard (1951, p. 87) says the living soft parts are "cream-coloured, the sides of the foot deepening to orange, with a bright orange edge, and the tentacles are yellow with two black stripes." There are several shell forms all showing intergradation. Below I outline a few of the more obvious ones:

forma zeylanicum (Lamarck)—Shell heavy, 40 to 90 mm. in length, globular, shoulder with 2 rows of prominent whitish nodules, those in the lower row being slightly smaller; last whorl faint yellow-brown with 3 or 4 spiral rows of squarish, faintly discernable bluish white spots; base of shell with 1 to 4 fine, spiral, incised lines; channel behind siphonal canal is fairly wide; early whorls white, but sometimes tan or pink. Columellar shield thick, glazed, usually white.

forma intercedens (von Martens)—Same as typical form, but with only one row of nodules on the shoulder.

form tri-noduled—Same as typical, but with a third row of nodules on the body whorl.

forma typical *iredalei* Bayer, 1935—Shell moderately heavy to light, 35 to 50 mm. in length, shoulder smooth but somewhat raised; color dark mauve-tan with 3 to 5 spiral rows of darker spots which are bordered anteriorly by an arrow-shaped white smear. Columellar shield weak and yellowish tan to taffy-brown. Channel posterior to the siphonal canal is narrow; early whorls usually pink or tan, rarely white.

form elongate—Same as *iredalei* but the shell is elongate (example: 35 x 20 mm.), and the body whorl has 6 spiral brown bands on top of which are numerous small white spots. (Resembles *Casuarina ponderosa uippouensis* Abbott).

Measurements (mm.)—

length	width	no. whorls	
92.3	71.5	7+	large; forma <i>zeylanica</i> ; Knysna
74.4	60.0	6+	holotype of <i>zeylanica</i> Lamarck
67.3	48.0	8	forma <i>intercedens</i> von Martens; Cape Town.
41.0	26.1	7+	typical <i>iredalei</i> Bayer; Port Alfred
22.0	14.5	6+	small; Jeffreys Bay

Synonymy—

- 1822 *Cassis zeylanica* Lamarck, Anim. sans Vert., vol. 7, p. 226, no. 18 (Ceylon); 1844, Deshayes, Anim. sans Vert., ed. 2, vol. 10, p. 33, no. 18; 1848, Krauss, Die Südafrikan. Mollusken, Stuttgart, p. 115, no. 2; 1835, Kiener, Coquilles Vivantes, vol. 8, Casques, pl. 13, fig. 26 (heavy, noded hybrid *labiatum* X *pyrum*).
- 1839 *Cassis zeylanica* Anton, Verzeichniss Conchyl. Samml., Halle, p. 94 (error for *zeylanica*).
- 1840 *Cassidea zeylanica* Lam., Swainson, Treatise Malacology, London, p. 299 (error for *zeylanica*).
- 1848 *Cassis pyrum* Lamarck, Reeve (in part), Conch. Icon., vol. 5, Cassis, pl. 11, fig. 29c only; 1915, Bartsch, Bull. 91, U.S. Nat. Mus., p. 95.
- 1848 *Cassis achatina* Lamarck, Krauss, Die Südafrikan. Mollusken, Stuttgart, p. 115, no. 2; 1951, Beginner's Guide S. Afr. Shells, ed. 2, p. 87, pl. 9, figs. 15, 16.
- 1869 *Cassis ceylanica* Lamarck, Paetel, Moll. Syst. et Catalogue, Dresden, p. 39 [error].
- 1880 *Cassis ceylanica* Lam., von Martens, in Möbius' Beiträge zur Meeresfauna Ins. Mauritius und Seychellen, p. 263 [error for *zeylanica* Lam.].
- 1892 *Cassis achatina* Lamarck, Sowerby, Marine Shells of South Africa, London, p. 23.
- 1901 *Cassis ceylanica* Paetel, Tate and May, Proc. Linn. Soc. N.S.W., pt. 3, p. 444.
- 1903 *Cassis pyrum* Lam., von Martens, Wiss. Ergebn. Gastropoden deutschen Tiefsee-Exped., "Valdivia" vol. 7, pt. A, p. 54, 56, note 12.
- 1903 *Cassis pyrum intercedens* von Martens, *ibid.*, pp. 54, 56, note 12 (South Africa). [one row of nodules].
- 1932 *Cassis achatina craticulata* Euthyme, Turton, Marine Shells of Port Alfred, South Africa, Oxford, p. 112, no. 806. Not *craticulata* Euthyme, 1885.
- 1932 *Cassis zeylanica* Lamarck, Turton, *ibid.*, no. 807 (error for *zeylanica*); 1915, Bartsch, Bull. 91, U.S. Nat. Mus., p. 95.
- 1932 *Cassis zeylanica nivea* Bruguière, Turton, *ibid.*, no. 808 (error for *nivea* Brazier, there being no *nivea* Brug.)
- 1935 *Phalium (Xenogalea) labiatum* var. *iredalei* Bayer, Zoolog. Mededeel., vol. 18, p. 109 (Port Elizabeth, South Africa). [smooth form].

1935 *Phalium pyrum* var. *zeylanica* Lamarck, Bayer, *ibid.*, p. 110.

Types—The type of *zeylanicum* Lamarck, 1822, is in the Museum de Genève in Switzerland. The type locality of Ceylon is obviously erroneous. The shell probably came from near Cape Town, possibly Muizenberg, in False Bay. Bayer's type of *iredalei* is in the Rijksmuseum in Leiden. The type came from "South Africa" and paratypes from Port Elizabeth. I did not locate von Martens' type of *intercedens*, but it may still be in the Zoological Museum in East Berlin.

Nomenclature—Although Bayer proposed his *iredalei* as only a variety, his name is nomenclatorially available. Lamarck's 1822 name, *zeylanicum*, is based, in my opinion, upon a hybrid form and we use it in that sense as a name for the heavy, noded *labiatum* X *pyrum* shells. Should anyone subsequently show or believe that the South African forms are one variable species, then Lamarck's name would have to be employed, with *iredalei* being reduced to a forma name.

Records—SOUTH AFRICA: CAPE PROVINCE: Cape Town (ANSP); Muizenberg Beach, False Bay (Helen Boswell, ANSP); Salt Vlei Beach, Klein River (V. Orr, 1955, ANSP); Cape Agulhas (V. Orr, 1955, ANSP); Stillbaai, Riversdale District (MCZ); Knysna (Helen Boswell, ANSP); Jeffreys Bay (A. C. van Bruggen coll'n., ANSP; MCZ); Port Elizabeth, Algoa Bay (ANSP; MCZ; USNM); Port Alfred (E. K. Jordan, ANSP; MCZ; USNM); East London (ANSP; MCZ); Coffee Bay, Transkei (V. Orr, 1955, ANSP); NATAL: Durban (rare; accurate data?) (H. C. Burnup, Natal Mus.).

***Phalium labiatum subspecies
iheringi* (Carcelles, 1953)**

(Pl. 175)

Range—Northern Argentina and southern Brazil.

Remarks and Description—This uncommon cassid is dredged offshore in waters of about 20 fathoms or more. The shell is brightly colored and characteristically has spiral rows of dark chestnut-brown, arrow-shaped blotches, which are bordered on their anterior concave sides by an opaque-white spot. The background color is yellowish cream. The thickened outer lip has 5 groups of mauve brown stripes, and has a few weak denticles on the lower, inner edge. The true umbilicus is fairly large and very deep, but

the false umbilicus is slit-like or sealed. Some specimens are elongate, others globose, and may have a smooth or weakly noduled shoulder. Nuclear whorls 3, smooth, bulimoid, and white. Operculum very similar to that of *labiatum labiatum*.

Measurements (mm.)—

length	width	no. whorls	
76.4	44.0	9	large; off Angra dos Reis, Brazil
62.5	38.0	8	average; off Ilha Grande, Brazil
60.0	41.0	7	holotype of <i>iheringi</i>
55.6	38.3	7	globose; Cassino Beach, Brazil
54.0	35.1	8	small; Isla de Lobos, Uruguay
48.8	32.8	7	small; Dept. Rocha, Uruguay

Synonymy—

- 1927 *Cassid pyrum*, von Ihering, Die Geschichte des Atlantischen Ozeans, Jena, p. 168 (Rio Grande do Sul).
 1953 *Phalium iheringi* Carcelles, Comunic. Zoologicas Museo Hist. Nat. Montevideo, vol. 4, no. 70, p. 5, pl. 2, figs. 7-10 (Mar del Plata, off Uruguay, 84 meters); 1966, Fontes, Neotropica, vol. 12, no. 37, pp. 38-40, 3 figs.
 1960 *Semicassis achatina* Lamarck, Barattini and Ureta, La Fauna de las Costas Uruguayas del Este, Concejo Dept. Montevideo, p. 122, pl. 37.

Types—The type locality is Mar del Plata, Uruguay, 84 meters. The holotype is in the Museo de Historia Natural de Montevideo, no. 13805.

Records—BRAZIL: deep water off Ilha Grande (Tursch, A. R. Cahn coll'n., ANSP); 20 meters, off Angra dos Reis, Rio State (E. Rios, 1958, Mus. Oceanogr. Rio Grande); Cassino Beach, Rio Grande do Sul (E. Rios, 1960, Mus. Oceanogr. Rio Grande). URUGUAY: Departamento de Rocha; off Isla de Lobos (both Mus. Nac. Hist. Nat. Montevideo). ARGENTINA: Mar del Plata (J. Pozzi, 1936, Mus. Hist. Nat. Montevideo); off Mar del Plata, 84 meters, S. Lat. 37° 38'; W. Long. 56° 20' ("Undine", 1926, Mus. Hist. Nat. Montevideo); off Puerto Quequén, S. Lat. 39° 30' (E. M. Fontes, 1966, p. 38).



Plate 175. *Phalium labiatum* subspecies *iheringi* (Carcelles, 1953). Off Ilha Grande, Brazil. ANSP no. 283737. 62.5 mm.

Genus *Casmaria* H. and A. Adams, 1853

Type: *Casmaria erinaceus* (Linné, 1758)

The genus *Casmaria* contains two tropical species whose small, glossy shells are characterized by an elongate shape, a columellar shield that is smoothish and poorly developed, and by one or two rows of sharp denticles on the outer lip. The false, or siphonal, umbilicus is closed. Both species exhibit two extreme shell forms, one

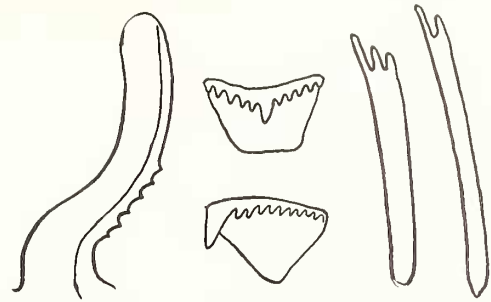


Plate 177. *Casmaria erinaceus* (Linné). Penis and radula from a Fiji specimen.

smooth and light-weight, the other strongly noduled and thick-shelled. Spiral sculpturing is virtually absent. The first two nuclear whorls are bounded at the suture by a microscopic dark-brown line. There is always a black-brown blotch on the siphonal canal. The operculum is fan-shaped to ovate, and bears three small reinforcement bars on the inner attachment side. The penis bears small sawtooth-like fleshy projections on one edge. The outer marginal radular tooth bears 2 or 3 long cusps.

A different genotype has been selected on three occasions, but the designation of *vibex* Linné (= *erinaceus* Linné, 1758) by Harris in 1897 is the first.

Synonymy—

1853 *Casmaria* H. and A. Adams, Genera of Recent Mollusca, vol. 1, p. 216. Type by subsequent designation by G. F. Harris, 1897, p. 200: *Buccinum vibex* Linné = *Casmaria erinaceus* (Linné, 1758). (Cossmann, 1903, p. 127 designated *pirum* Lam., and Cotton, 1945, p. 251, gave *ponderosa* Gmelin, 1791).

1888 *Casmeria* Jousseaume, Memoirs Soc. Zool. France, vol. 1, p. 190. Type by monotypy: *Cassia torquata* Reeve = *ponderosa* Gmelin, 1791.

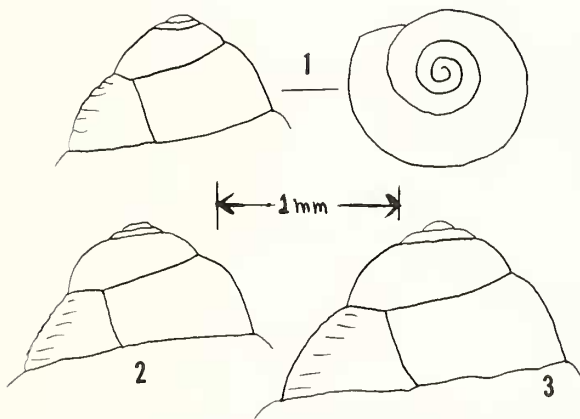


Plate 176. Nuclear whorls of *Casmaria*. Fig. 1, *ponderosa ponderosa* (Gmelin), Indo-Pacific. 2, *erinaceus* (Linné). 3, *ponderosa atlantica* Clench, Caribbean.



Plate 178. World distribution of the genus *Casmaria*. 1, *erinaceus* (Linné); 1a, *erinaceus* subspecies *vibexmexicana*

(Stearns); 2, *ponderosa* (Gmelin); 2a, *ponderosa* subspecies *atlantica* Clench.

Casmaria erinaceus subspecies
erinaceus (Linné, 1758)

(Pl. 14, figs. 7-12)

Range—Red Sea and East Africa to Melanesia and Micronesia.

Remarks—This widely distributed, moderately common *Casmaria*, called *vibex* Linné by some workers, is quite variable in sculpturing and coloring, and in some cases, is difficult to distinguish from *ponderosa* (Gmelin). It occurs in two forms, often with intergrades, throughout most parts of its range—the typical, heavy, smaller *erinaceus* with nodules on the shoulder, and the smooth, usually larger, lighter form, *vibex* Linné.

In general, it differs from *ponderosa* in being more elongate, in having less globose whorls, in having 3 to 6 rather sharp prickles limited to the lower portion of the outer lip, in lacking square, brown spots both on the base of the body whorl and just below the suture, and in usually having axial rows of very tiny, brown “fly-speck” dots on the coarse growth lines of the body whorl. I have not seen these “fly-specks” in *ponderosa*.

In most cases, the very upper portion of the outer lip of *erinaceus* bears a varical brown spot which is about the level of the suture. In *ponderosa*, this area of the varix is white, so that the uppermost brown spot is well below the level of the suture. Small, heavy, noded specimens of both species are very similar, but in *ponderosa* there are two rows of prickles on the upper part of the outer lip, the inner row being the terminal ends of spiral lirae within the aperture.

The shells of *erinaceus* exhibit several interesting color forms which I believe are of genetic origin but which may be accentuated by environmental conditions. Some of them, because of their clinal nature and sometimes sporadic and geographically widespread occurrence, I consider as mere forms. With some hesitancy I recognize a Hawaiian and Polynesian subspecies, namely *kalosmodix* (Melville). Its peculiarities and distribution are discussed below. The color form of axial, chestnut “zigzag stripes” (a single gene?) is commonest in the Philippines and Indonesia, but rarely occurs in northeast Australia, Melanesia, Micronesia, and in a few Hawaiian specimens of the subspecies *kalosmodix*. The color form bearing black-brown “fly-specks” occurs commonly throughout most of the species’ range, although, curiously, it is rare in the Philippine

area. A light-colored ecologic form is found associated with small atolls, while darker shells are associated with volcanic islands.

A subspecies, *vibexmexicana* (Stearns), occurs in the waters around southern Lower California, Mexico, and the Galapagos. Curiously, it resembles Indian Ocean specimens rather than those of the neighboring Polynesian subspecies.

Description—Adult shell 24 to 70 mm. (1 to 2-3/4 inches) in length, solid, glossy, elongate, with a smoothish, rounded columella, with strong, black-striped varix, with small prickles at the base of the varix, and without an umbilicus. Whorls 8. Nuclear whorls 3, the first very small and stained brown, the remaining two rapidly increasing in size, glossy, white and smooth. The whorl dips slightly, and forms a break in the growth just before the postnuclear whorls begin. Body whorl slightly rounded and with a smooth or a strongly noded shoulder. Color of shell whitish, cream or tan with or without 5 to 6 weak spiral bands of darker tan, brown or mauve-brown, and with or without darker brown axial, wavy streaks. Body whorl may have axial rows of microscopic black pin-points or “fly-specks” along former growth resting stages. Varix poorly to strongly developed, with 10 to 20 black-brown stripes. Rarely with a former varix. Base of outer lip with 4 to 6 tiny, sharp prickles. Columellar shield solid, white, rounded, with a slight spiral swelling in the middle, and with one strong lower and several weak upper spiral wrinkles disappearing within the aperture. Interior of aperture tan to brown. Umbilicus sealed over; false umbilicus absent. Siphonal canal short and at the base of the dorsal slot stained black. Operculum 1/4 the length of the aperture, corneous, thin, yellowish, fan-shaped and with weak growth lines.

Measurements (mm.)—

length	width	no. whorls	
69.5	40.8	8	large; Okinawa Id.
53.0	30.5	8	average; Zanzibar Id.
35.6	20.5	7	small; Samar, Philippines
24.0	14.1	7	smallest; Samar, Philippines

Synonymy—

- 1758 *Buccinum erinaceus* Linné, *Systema naturae*, ed. 10, p. 736, no. 390 (O. Americano); refers to Rumphius, pl. 26, fig. 7; Gualtieri, pl. 39, fig. 1.D; Argenville, pl. 17, fig. C; 1764, Linné, *Museum Lud. Ulricae*, p. 605, no. 255; 1767, Linné, 12 ed., p. 1199, no. 452. [noded form]; 1956, Dodge, *Bull. Amer. Mus. Nat. Hist.*, N.Y., vol. 111, art. 3, pp. 185-188.
- 1758 *Buccinum vibex* Linné, *Systema naturae*, ed. 10, p. 737, no. 392 (Jamaican); refers to Bonanni, pl. 152;

Rumphius, pl. 25, figs. E, 8, 9; Gualtieri, pl. 39, figs. L, F; Argenville, pl. 17, fig. H; Regenfuss, pl. 10, fig. 40 [smooth form]; 1764, Linné, Museum Lud., Ulricae, p. 606, no. 257; 1767, Linné, 12 ed., p. 1200, no. 454; 1855, Hanley, Ipsa Linnaei Conchylii, London, p. 247.

1798 *Cassis denticulata* Röding, Museum Boltenianum, Hamburg, pt. 2, p. 32, no. 379; refers to Conchyl.-Cab., vol. 2, fig. 363. Not G. Fischer, 1807, which is *Quimalea pomum* Linné.

1798 *Cassis denticulata* Röding, Museum Boltenianum, Hamburg, pt. 2, p. 32, no. 379; refers to Conchyl.-

1807 *Phalium edentulum* Link, Beschreibung der Natur-Samml., Rostok, pt. 2, p. 113; refers to Conchyl.-Cab., vol. 2, fig. 363 [without prickles on outer lip].

1857 *Cassis vibex* Linné, Küster, Systemat. Conchyl.-Cab., new series, vol. 3, pt. 1 b, p. 12, pl. 38, figs. 4-7, pl. 47, figs. 3, 4, pl. 51, figs. 5, 6.

1866 *Cassis vibex* var. *ventricosa* Rigacci, Cat. Conch. Collezione Rigacci, Rome, p. 44, no. 4326 (no locality). Nomen nudum.

1927 *Casmaria erinaceus* Linné and *vibex* Linné, Iredale, Records Australian Mus., vol. 15, p. 337.

1935 *Phalium (Casmaria) erinaceum* Linné, Bayer, Zoologische Mededeel., Leiden, vol. 18, p. 112.

Types—Specimens of both *vibex* and *erinaceus* are found in the Linnaean Society collection in London, each being properly marked by Linné, according to Hanley and to Dodge. *B. vibex* is the smooth shouldered form. I could not locate Link's type of *edentulum*, nor identify the Martini specimens in Copenhagen upon which Röding based his *denticulata* and *glabra*. I hereby designate Amboina, Indonesia, as the type locality for *erinaceus* Linné. Linné gave "Jamaica" as the type locality of *vibex*, but this was probably erroneous.

Nomenclature—Linné considered the smooth-shouldered and nodule-shouldered forms as separate species, *vibex* and *erinaceus* respectively. So did most early workers (Born, 1778; Gmelin, 1791; Bruguière, 1792; G. Fischer, 1807; Dillwyn, 1817, etc.)

Later workers considered them as varieties or synonyms of each other. Link (1807) was one of the first to state that *vibex* was merely a form of *erinaceus*. Ch. Bayer (1935, p. 112) and Iredale (1927, p. 337) pointed out that Linné's secondly proposed name, *vibex*, would have to be used as a variety or form name, if the two entities were to be lumped. Iredale lumped the smooth and noded forms of *ponderosa* (Gmelin), but apparently could not draw himself to do the same with *erinaceus* and *vibex*. I merge them without hesitancy. Hanley (1859, p. 247) and Reeve (1848) were largely responsible for the use of the name *vibex* in later popular books.

The name "*Buccinum Meles* Solander" was listed as a synonym of the noded *erinaceus* Linné in Dillwyn, 1817, p. 599 text. The name is invalid, as is "*pantherina* Solander" on the same page, which is *ponderosa* (Gmelin).

In describing his *Buccinum vibex*, Linné might well have had a mixture of the smooth form from the Indo-Pacific and a specimen of *Casmaria ponderosa atlantica* Clench, for he gave Jamaica as the type locality.

Records—(Also see accompanying distribution map)—MOZAMBIQUE: Porto Amelia (ANSP; MCZ). ZANZIBAR: Pwani Mchangani; outer reef at Kiwengwa (both A. J. Ostheimer, 3rd, 1957). INDIAN OCEAN IDS.: Agalega Id., 400 mi. north of Mauritius (ANSP); Gloriosa Id. (W. L. Abbott, USNM); Mauritius (MCZ); Mauome, Mauritius (Mauritius Inst.); Rodriguez Id. (Slater, Brit. Mus.); Cargados Id. (Mauritius Inst.; ANSP). MADAGASCAR: Sarondrano (R. W. Foster, MCZ); Nossi-bé (A. Chavane, ANSP); Nossi Iranja (Wm. Dodd, ANSP); Ile Ste. Marie (R. W. Foster, MCZ). SEYCHELLES: (M. B. Banks, MCZ; ANSP). RED SEA: Geb Zet (Berlin Mus.); Eilat, Gulf of Aqaba (A. Hadar, ANSP). MALDIVES: Mulaku Atoll (Peggy Carpenter, ANSP); Gafaro Id., north Malé Atoll (R. Jonklass, ANSP); South Nilandu Atoll (R. Robertson, 1964, ANSP). COCOS-KEELING: Pulo

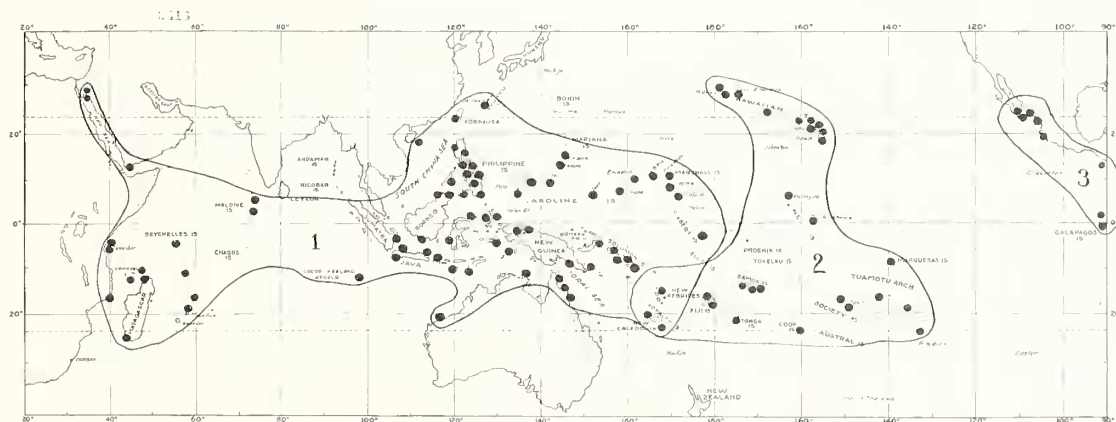


Plate 179. Geographical distribution of *Casmaria erinaceus* (Linné) and its subspecies. 1, typical subspecies *erinaceus* (Linné); 2, subspecies *kalosmodix* (Melvill) showing inter-

grades occurring in southeastern Melanesia; 3, subspecies *vibexmexicana* (Stearns) which more closely resembles the typical subspecies.

Beras (Gibson-Hill, USNM). RYUKYU IDS.: Metasaki, Okinawa Id. (Bernice Albert, ANSP); Ishigaki (A. S. Anderson, ANSP); Sakishima, Yaeyama Id. (A. A. Scott coll'n.). TAIWAN: Taihokusyü; Kiirun; Suo; Takao; Hoko (all Kuroda, 1941, p. 104). PHILIPPINES: numerous reef records from such islands as Luzon, Samar, Bohol, Cebu, Camiguin, Balabac, Cuyo, Mindanao, Sulu Archipelago (Sanga Sanga) (all ANSP); Basilan, Masbate, Negros, Jolo, Lubang (all USNM); Calapan (MCZ). NORTH BORNEO: Mandi Darrah Id.; Semporna. (Mary Saul, ANSP). INDONESIA: Japanoeli, west Sumatra; Kei Id.; Banda Neira; Poelwe Hinako, near Nias; Lintido, Celebes (all Zoolog. Mus. Amsterdam); Ambon (Naturhist. Mus. Enschede); Basa Id., Gulf of Boni, Celebes; Taganak Id., Borneo (both USNM); Pulu Panaitan, west Java (L. J. Butot coll'n.); Banka Id. (east Sumatra); Madura; Boeroe Id., Sunda Ids.; Timor (all Rijksmus. Leiden); Geser Atoll, Ceram Id., (Paleo. Res. Inst. Ithaca); Tengah Id., off Boeroe and Morotai, Moluccas; Wodo Id., west of Halmahera Id.; Bali, Sunda Id.; Gorontalo, Celebes Id. (all MCZ); Kera, near Koepang, Timor (Snellius Exped., 1929, Rijksmus. Leiden). AUSTRALIA: WESTERN AUSTRALIA: Long Id., Dampier Archip. (Weaver and King, 1960, BPBM). NORTHERN TERRITORY: New Year Id. (V. Wells, ANSP). QUEENSLAND: Heron Id.; Fitzroy Id.; Lady Musgrave Id., east of Gladstone (all Aust. Mus.); Rudder Reef, off Port Douglas (Tony Marsh, ANSP). NEW GUINEA: reef flats, Soepiori Id., Schouten Ids.; Mios Woendi Atoll, Padaido Id. (both A. J. Osheimer, ANSP); Fak-Fak (Rijksmus. Leiden); Milne Bay (USNM); Finschhafen Bay (MCZ). BISMARCKS: Kaliai Reef, New Britain Id. (H. Coutournas, ANSP); Kaveing, New Ireland (West. Aust. Mus.). SOLOMONS: Buka, Bougainville Id. (MCZ); Treasury Id. (USNM); Pavuvu Id., Russell Group (USNM); Ususne, Malaita Id. (J. van der Riet, ANSP). MARIANAS: Guam (ANSP; USNM); Saipan (R. Sutcliffe, ANSP). PALAUS: Peleliu Id. (ANSP). CAROLINES: Ponape (A. J. Kohn, ANSP); Yap; Satawal Atoll (both USNM). MARSHALLS: Bikini; Eniwetok; Rongelap, Rongerik, Ailuk, Wotho Atolls (all USNM). GILBERTS: Apaiang (MCZ). NEW CALEDONIA: Voh (Paris Mus.); Koë Reef, Touho (G. and M. Kline, Orr, ANSP).

Casmaria erinaceus subspecies
kalosmodix (Melvill, 1883)

(Pl. 14, fig. 17)

Range—Hawaiian Chain and Polynesia.

Remarks—It is with some hesitancy that I accept this form as a subspecies, for in some parts of its distribution it differs from the typical *erinaceus* in only one color character. Originally, this subspecies was established by Melvill on the basis of a very large specimen lacking the prickles on the outer lip. Although the habitat locality of the holotype is unknown, and despite the fact that Melvill claimed to have received a second specimen from Ceylon, I think it most probable that the original specimen came from the northwest Hawaiian Islands.

The absence of tiny spines or prickles is not at all diagnostic of this subspecies, for I have seen many specimens with them from Midway.

From Kauai to Hawaii and throughout the Polynesia Islands specimens bear 2 to 5 (usually 4) well-developed spines. Specimens from Midway to Necker are unusually large, sometimes reaching a length of four inches (103 mm.), and are progressively smaller towards the southeast. This phenomenon exists in other gastropods, such as *Terebra maculata* Linné. Curiously, 10 of 56 specimens examined from Midway have an extra varix one half whorl behind the last varix. Among the hundreds of specimens I have seen from the Philippines, I have seen only three with a second varix.

I find three overlap areas where both the typical race and *kalosmodix* occur, these being New Caledonia, Fiji and Malaita Island in the Solomons. Probably the New Hebrides are also within this boundary area. It is rather interesting that the subspecies *vibexmexicana* (Stearns) from Lower California is extremely close morphologically to Indian Ocean specimens, and lack the subsutural flames of chestnut which characterize the adjacent Polynesian race. It is possible that the Polynesian race is a very recent development, say, within the last 10,000 years, and that its characters are spreading to other populations westward towards Melanesia and the East Indies.

Description—The subspecies *kalosmodix* is best characterized by the dark-brown, oblong, irregularly-shaped blotches located just below the suture. The blotches are rarely as squarish as those in *C. ponderosa*, nor are they present on the base of the shell. The upper section of the outer lip (the varix) is usually without a brown stripe, a character more common in *ponderosa*. Rarely, in Oahu specimens, the blotches are continued over the body whorl in the form of "zebra-like" stripes. This subspecies may have a smooth or, rarely, a noded shoulder. The interior of the aperture may have a violet tint in fresh specimens, which with age turns brownish.

Measurements (mm.)—

length	width	no. whorls	
103.0	58.0	8	large; Midway; BPBM
78.0	41.8	7	large; Midway; MCZ
56.0	31.5	7	average; Tutuila Id., Samoa
35.4	20.5	7	small; Midway; ANSP
25.7	15.0	6	smallest; Midway; ANSP

Synonymy—

1857 *Cassis vibex* var., Küster, Systemat. Conchyl.-Cabinet, new series, vol. 3, pt. 1 b (395th part of 1892), p. 35, pl. 50, fig. 7 (no locality).

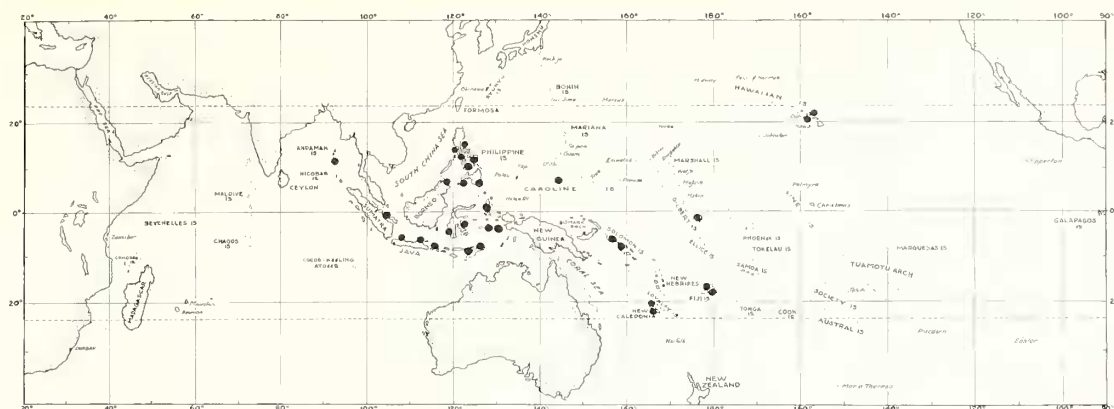


Plate 180. Distribution of a single character (zigzag stripes on the outer shell) over the range of two subspecies of *Casmaria erinaceus* (Linné).

1883 *Cassis kalosmodix* Melvill, Journal of Conchology, vol. 4, p. 43, pl. 1, fig. 1, (locality unknown); 1905, *ibid.*, vol. 11, p. 177 (Ceylon [error?])

1958 *Casmaria erinaceus* (Linnaeus) and var. *kalosmodix* (Melvill), Tinker, Pacific Sea Shells, Tuttle Co., ed. 2, p. 86, figs. top row center and lower right.

Types—The type of *Cassis kalosmodix* Melvill is in the Tomlin collection in the National Museum of Wales, United Kingdom. Since Melvill gave no locality in the original description we select Midway, Hawaiian Chain.

Nomenclature—There may be two earlier names for this subspecies, although there is no proof, and the probabilities are very slight. Link proposed the name *Phalium edentulum* in 1807, referring to a smooth form of *erinaceus* (Conchyl.-Cab., vol. 2, fig. 363; no locality) and commenting “our specimen equals the figure but the description talks about teeth.” I have relegated the name to the synonymy of *erinaceus* forma *vibex* Linné. In 1798, Röding applied the name *Cassis glabra* to Lister’s plate 1013, fig. 77. That figure might be construed as either of three shells (*ponderosa* forma *quadrata* (Link), *erinaceus* forma *vibex* (Linné), or possibly *kalosmodix* Melvill). I believe it wisest to sink it in the synonymy of *erinaceus*, and perhaps declare it a *nomen oblitum*.

Records—HAWAIIAN CHAIN: Ocean Id. (Kure); Midway; Laysan Id.; Lisianski Id. (all BPBM); Pearl and Hermes Reef (MCZ and USNM); Kauai Id. (MCZ); Niihau Id. (BPBM). OAHU ID.: off Waikiki; Paumotu; Mokapu (BPBM); Rabbit Id., 7 fms., off Mokulua Ids., Lanikai (both Clifford S. Weaver). MAUI ID.: Puunoa Pt., Lahaina (BPBM). LINE ISLANDS: Palmyra; Christmas (both BPBM). NEW CALEDONIA: Lifu Id. (Manchester Mus.); Voh (M. Defour, ANSP). SAMOA: Tutuila Id.; Upolu Id. (both ANSP); Savage Id., south of Samoa (Brit. Mus.); Ofu Id. (BPBM). TONGA: Tongatapu Id. (Saia Tuipulotu, ANSP, 1965). COOK IDS.: Li-



Plate 181. *Casmaria erinaceus* subspecies *vibexmexicana* (Stearns, 1894). Off Lobos Island, La Paz, Mexico. 70 mm. (courtesy of W. K. Emerson).

kopua Islet, Aitutaki (R. Robertson, 1952, ANSP); Mauke Id.; Rarotonga Id. (both H. J. Morgan collection). SOCIETY IDS.: Aitue, Punoauia, Tahiti Id. (R. Robertson, ANSP); Bay Vairahi, Raiatea Id. (Wesley Heilman, ANSP); TUA MOTU IDS.: Raroia Id. (J. P. E. Morrison, USNM); Vahitahi Id. (D. Marshall, USNM); Gambier Id. (Seurat, Paris Mus.). [records from the Marianas need confirmation].

Casmaria erinaceus subspecies *vibexmexicana* (Stearns, 1894)

(Pl. 181)

Range—Southern region of Lower California to Panama; Galapagos Islands.

Remarks—Although no living specimens of this subspecies have as yet been collected, the ten reliable locality records leave little doubt that *Casmaria erinaceus* exists in Eastern Pacific

waters. Curiously, these specimens closely resemble specimens from the Indian Ocean and the Southwest Pacific in nearly all respects, including the presence of minute, blackish, axial rows of "fly-speck" dots along former growth stoppages. Unlike the Polynesian subspecies, *kalosmodix* (Melvill), they have no brown, short, axial flames below the suture. This may suggest that the invasion from the central Pacific to the Eastern Pacific (or reverse direction) took place before the development of the Polynesian race. I can find no worthy differences between *vibex-mexicana* and *erinaceus erinaceus*, save that the former has a purplish interior to its aperture. Of possible significance, as Keen notes (1960), are "two diffused spots of yellow at the anterior end of the aperture, one on either side of the canal opening." I am, for geographical and practical reasons, treating *vibexmexicana* as a subspecies until study of the soft parts can be made.

Measurements (mm.)—

length	width	no. whorls	
70.0	42.0	6+	Lobos Id., near La Paz
41.5	26.0	6+	San Juanito Id., AMNH
34.9	21.5	5+	holotype, USNM

Types—The type locality is María Madre Id., Tres Marias Islands, Mexico. The holotype is in USNM 88831.

Synonymy—

- 1893 *Cassis* (*Casmaria*) *vibex* Linné, Stearns, Proc. U.S. Nat. Mus., vol. 16, no. 941, p. 348 (Tres Marias and La Paz, Lower California); 1958, Keen, Sea Shells of Tropical West America, Stanford, p. 340.
 1894 *Cassis* (*Casmaria*) *vibex-mexicana* Stearns, Proc. U.S. Nat. Mus., vol. 17, no. 996, p. 188; refers to his 1893 description (María Madre Islands, Tres Marias Ids., and La Paz, Lower Calif.); 1933, Lowe, Nautilus, vol. 46, p. 112; 1937, Hertlein, Proc. Amer. Philos. Soc., vol. 78, no. 2, p. 306; 1960, Keen, ed. 2, p. 340, fig. 314; 1963, Emerson and Old, Jr., Nautilus, vol. 76, no. 4, p. 143, pl. 10, figs. 1-3.

Records—EASTERN PACIFIC; MEXICO—Baja California: San Jose Id. (H. W. Lowe, 1932); Santa Catalina Island (W. K. Emerson, 1962); Buena Vista, Palmos Bay (Antonio Verdugo, 1961); Lobos Island, in 20 feet of water, near La Paz (Verona McKibbin); La Paz (L. Belding, 1892); Tres Marias Islands: María Madre Id. (W. K. Fisher, 1892); María Cleofas Id. (George Willett, 1938); San Juanito Id. (W. K. Emerson, 1961). [records from Emerson and Old, 1963]. COSTA RICA: Coronado (Jane Ruer, 1932, ANSP). PANAMA: Pearl Islands (F. H. Bradley, 1866, Yale Peabody Mus.). GALAPAGOS IDS.: Espumilla Beach, James Bay, San Salvador Id.; beach on Jervis Id. (both Mrs. Carmen Angermeyer, coll.).

**Casmaria ponderosa subspecies
ponderosa (Gmelin, 1791)**

(Pl. 14, figs. 1-4; pls. 182-185)

Range—Red Sea and East Africa to eastern Polynesia.

Remarks—*Casmaria ponderosa* (Gmelin) usually differs from *erinaceus* (Linné) in having two rows of prominent square blotches, one just below the suture, the other on the base of the body whorl. Polynesian specimens of *erinaceus* have oblong blotches below the suture but none at the base of the shell. In *ponderosa*, there are one or two rows of prickles usually running the entire length of the outer lip. The spire is proportionately higher and the whorls more globose in *ponderosa*.

Casmaria ponderosa (Gmelin) is a very variable and widely distributed species found in shallow, sandy areas. In examining and geographically arranging over 200 lots of perhaps a thousand specimens, I have concluded that two additional subspecies should be recognized because of their isolation and several constant characters, namely *nipponensis* Abbott and *atlantica* Clench, 1944. However, I note the presence of certain single characters in certain areas which suggest incipient subspecies. I refer to these as forms since they may be rare or common in any given locality, and they may occur in combinations without uniform geographical distributions. Although some of these forms have received names in the past, I think it wise not to accept them even as subspecies.

C. ponderosa of the tropical Indo-Pacific may be heavy with strong plications on the shoulder

or be light-weight and with a smooth body whorl. Intergrades exist in many localities, although the heavy form appears to be more prevalent in the area of coral atolls and outer reefs. The smooth shells are the form *quadrata* (Link, 1807), which Reeve also named *torquata* in 1848. Sowerby illustrated it in 1842 in figure 411 of his "Conchological Manual".

The form *turgida* (Reeve, 1848) appears to be limited to the central Philippines. The shells are light-weight, thin, somewhat globose, smooth, with 8 to 12 prickles on the outer lip, and especially characterized by axial, wavy, zigzag brown bands or stripes. The square subsutural blotches are poorly defined, and are scarcely evident on the base. The shell is large, ranging from 42 to 55 mm. in length, (see pl. 184). This form should not be confused with the "zebra-striped" color phase of *erinaceus* which is commonest in the southwest Pacific area (see pl. 14, fig. 9). It is quite possible that the form *turgida* is a hybrid between *ponderosa* and *erinaceus*. Large, rotund, smooth specimens of *ponderosa* occasionally are present in the Red Sea, but they lack the zigzag brown bands. The "Challenger" specimen from the Admiralty Islands (Watson, 1886, p. 409) is a young, smooth *ponderosa* and not the form *turgida*.

The form *cernica* (Sowerby, 1888), originally described from Mauritius, has appeared in the Red Sea. I have hesitated to recognize it as a subspecies. Typical forms of *ponderosa* also occur in Mauritius. Curiously, the Caribbean subspecies, *atlantica* Clench, is almost indistinguishable from this form. In both, the shells are light-weight, with 4 to 7 prickles on the lower half of the outer lip, and with 3 spiral rows of light-fawn, squarish spots on the middle of the body whorl between the usual subsutural and

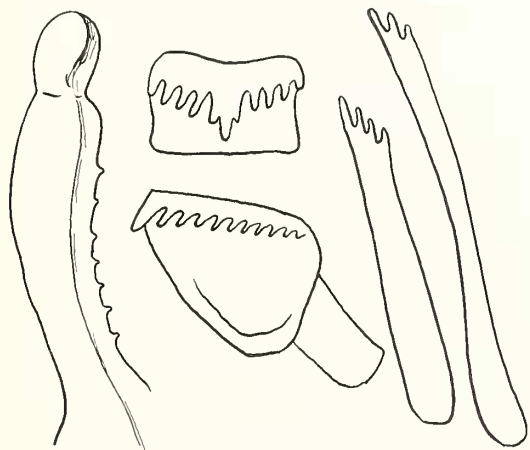


Plate 182. *Casmaria ponderosa* (Gmelin). Penis and radulae from knobbed form from Fiji Islands.

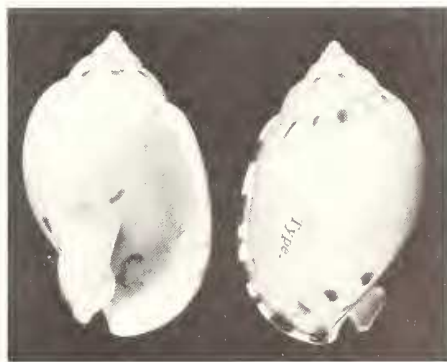


Plate 183. *Casmaria ponderosa* (Gmelin, 1791) forma *quadrata* (Link, 1807). Holotype of *Cassis torquata* Reeve, 1848. 31 mm. in length. British Museum (Natural History).

basal color spots. Examples of *cernica* are found on our plate 14, fig. 18 and in Kiener, 1835, Coquilles Vivantes, Paris, vol. 8, pl. 11, figs. 21a. The shape of the small shell is more like that of the elongate *erinaceus*. I believe this form may be the remnant of an earlier stock which was widespread throughout the Tethys Sea, perhaps during the early Miocene. It has changed little since then in the Caribbean, but in the Indo-Pacific has been gradually swamped out by the centrally located *ponderosa* and *quadrata* forms. A *cernica*-like subspecies is dominant in the cooler Japanese waters, and is discussed below under the remarks of *nipponensis* Abbott.

The coral atoll form, *nodulosa* (Gmelin, 1791), is common in Micronesia and sporadically present in Melanesia, Indonesia and the Maldives Islands. This form is reminiscent of the Micronesian race, or ecologic form, *Strombus variabilis athenius* Duclos, 1844 (see Indo-Pacific Mollusca, vol. 1, no. 2, p. 104 [p. 09-942]). In both, the shell is heavy, stunted, lighter in color and with a more extended spire. In this *Casmaria*, the shells are strongly noduled at the shoulder, the varix is very thick, the peristome is thickened, the spire is usually quite high, and the number and density of the color spots are greatly reduced. In some, the shell is almost all-white, except for the brown, varical blotches. This form is dominant in the Marshall, Caroline and Gilbert Islands, but occasionally occurs in northern New Guinea, the Philippines, Indonesia, Palau Islands and the Maldives in the Indian Ocean. I suspect this form, and that of the *Strombus*, is due to ecologic conditions, such as the absence of rich, high island muds.

Description—Adult shell 20 to 55 mm. ($\frac{3}{4}$ to 2 inches) in length, solid, glossy, ovate-elongate, with a smoothish, rounded columella, with a moderately-developed, black-striped varix, with one or two rows of denticles on the outer lip, and with a subsutural and basal spiral row of squarish chestnut splotches on the last whorl. Whorls 8. Nuclear whorls 3, the first very small and stained brown, the remaining two rapidly increasing in size, glossy, white and smooth. The whorl dips slightly and forms a break in the growth just before the postnuclear whorls begin. Body whorl well-rounded and with a smooth or axially noduled shoulder. Color of shell white, tan, bluish white or cream with a spiral row of about 7 to 9 chestnut squarish spots just below the suture and on the base of the body whorl. Between these two rows may be

3 weak spiral tan bands or 3 rows of weak, squarish spots. In smooth, light-weight specimens, the varix bears 5 to 12 small, sharp denticles, but in noduled, heavy specimens there is a second row of more numerous, smaller denticles slightly within the aperture. A former varix is very rarely present. The top or posterior end of the varix is without a chestnut stripe, but below are 7 to 10 variously-sized chestnut to blackish bands. Columella shield solid, white, rounded, smoothish or with numerous spiral wrinkles. Interior of aperture white to light-brown. Umbilicus sealed over; false umbilicus absent. Siphonal canal short and tipped with a chestnut splotch. Operculum one-fourth the length of the aperture; fan-shaped; narrow (12 x 4.5 mm.), and translucent-yellow.

Measurements (mm.)—

length	width	no. whorls	
51.5	30.0	8	form <i>turgida</i> Reeve; Cebu Id.
42.2	26.8	8	average; smooth; Cebu Id.
41.0	25.5	8	average; noduled; Bohol Id.
37.1	23.7	8	holotype of <i>torquata</i> Reeve
20.0	12.5	7	smallest; Mozambique

Synonymy—

- 1791 *Buccinum ponderosum* Gmelin, Systema naturae, ed. 13, p. 3477, no. 28 (no locality); refers to Lister, pl. 1016, fig. 74 [nodulose form].
 1791 *Buccinum nodulosum* Gmelin, loc. cit., p. 3479, no. 38 (no locality); refers to Schroeter's Einl. in Conch., vol. 1, p. 383, pl. 2, fig. 9. Non Gmelin, loc. cit., p. 3496 [coral atoll form].
 1792 *Cassidea erinaceus* Linné, Bruguière, Encyclopédie Méthod. (Vers), vol. 1, p. 418.
 1807 *Phalium quadratum* Link, Beschreibung der Natur-Samml., Rostok, pt. 2, p. 113; refers to Conchyl.-Cab., vol. 2, figs. 385, 386 [smooth form].

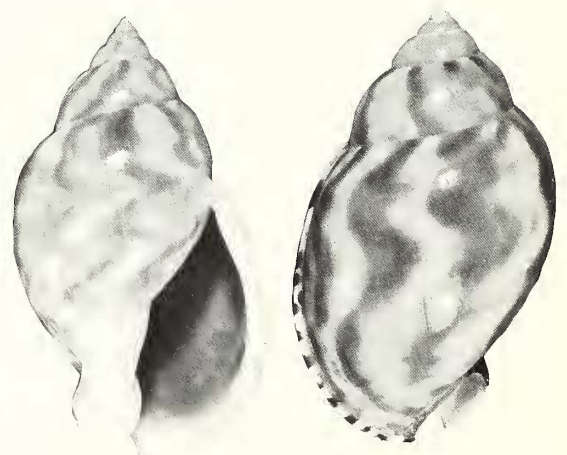


Plate 184. *Casmaria ponderosa* (Gmelin, 1791), forma *turgida* (Reeve, 1848). Laminusa Id., near Siasi, Sulu Archipelago, Philippines. Both 67 mm. Western Australian Mus. no. 863-66.

- 1817 *Buccinum biarmatum* Dillwyn, Descriptive Catal. Shells, London, vol. 2, p. 599, no. 32 (no locality). New name for *Buccinum nodulosum* Gmelin, 1791, p. 3479, non Gmelin, p. 3496.
- 1817 *Buccinum pantherina* "Solander" Dillwyn, loc. cit., p. 599 (indirectly refers to Conchyl.-Cab., vol. 2, figs. 383-386).
- 1828 *Cassis nodulosa* Gmelin, Menke, Synopsis method. Molluscorum, Pymont, p. 36.
- 1828 *Cassis tenuilabris* Menke, loc. cit., p. 36 and 87 (ad Javum); 1830, ed. 2, p. 145.
- 1848 *Cassis torquata* Reeve, Conchologica Icon., vol. 5, *Cassis* sp. and fig. 1 (New Holland).
- 1848 *Cassis turgida* Reeve, loc. cit., vol. 5, *Cassis* sp. and fig. 25 (Boljoon, Island of Zebu, Philippines); 1859, Chenu, Manuel de Conch., vol. 1, p. 207, fig. 1131.
- 1857 *Cassis torquata* Reeve, Küster, Systemat. Conchyl.-Cabinet, new series, vol. 3, pt. 1 b, p. 15, pl. 39, figs. 3-6, pl. 48, figs. 5, 6, pl. 49, figs. 5, 6.
- 1888 *Casmeria torquata* Reeve, Jousseume, Mém. Soc. Zool. France, vol. 1, p. 190.
- 1888 *Cassis cernica* Sowerby, Proceed. Zool. Soc. London, 1888, p. 211, pl. 11, fig. 19 (Mauritius).
- 1910 *Cassidea nodulosa* Gmelin var. *torquata* Reeve, Hedley, Report Australian Assoc. Adv. Sci., Brisbane, 1909, p. 361 (Queensland).
- 1927 *Casmaria ponderosa* (Gmelin), Iredale, Records Australian Mus., vol. 15, p. 338; 1961, Habe, Coloured Illus. Shells of Japan, vol. 2, pl. 21, fig. 3.

Nomenclature—During the 18th and 19th centuries, this species was erroneously referred to as Linné's *erinaceus* by various authors and it also received a number of synonyms. Iredale in 1927 was the first to present a good account of the synonymy and to establish the use of Gmelin's name of *ponderosa*. His concept of the species, however, was largely based on Australian specimens. I add the names *turgida* Reeve, 1848, and *cernica* Sowerby, 1888, to the synonymy. Dillwyn and Iredale have pointed out that Gmelin described two *Buccinum nodulosum*. The one on page 3479 is the coral atoll

form of our *Casmaria ponderosa* (Gmelin), and the one on page 3496 (a homonym) is "*Murex morbosus* Dillwyn, 1817", a *Thais* (?*rustica* Lamarck, 1822) from the West Indies. In all likelihood, *Cassis tenuilabris* Menke, 1828, from Java is the typical form of *ponderosa*.

Types—Gmelin evidently had no specimens. His *ponderosa* is based upon Lister's plate 1016, fig. 74, which is a drawing of a shell now probably in Lister's collection in the Oxford University Museum. Reeve's holotype of *torquata* and syntypes of *turgida* are in the British Museum (Natural History). Sowerby's type of *cernica* (1888) seems not to be identifiable. Sowerby and Fulton probably received several dozen specimens which were sold to several people, including Tryon (ANSP no. 107802) and Melvill (now in the National Museum of Wales, Cardiff).

Records—(also see accompanying map. Solid dots: specimens examined). NATAL: Durban (E. A. Smith, 1903, p. 379). MOZAMBIQUE: Mozambique City (Kurt Grosch, ANSP); 10 meters, Nacala (F. B. Steiner, ANSP); Porto Amelia (F. M. Borges, ANSP). ZANZIBAR: Chumbe Id.; ½ mi. south of Nyange Id. (both A. J. Ostheimer, 3rd, ANSP). MADAGASCAR: Nossi-bé (A. Chavane, ANSP); Ankifi, near Nossi Komba; Nossi Iranja; (both ANSP Exped., 1961); Ile Ste. Marie (R. W. Foster MCZ). MAURITIUS: Pointe aux Sables (ANSP). CHAGOS: (form *cernica*; Poisson, H., 1953, p. 66). SEYCHELLES: Cerf Id. (A. J. Kohn, Yale Peabody Mus.). MALDIVES: Gan Id., Addu Atoll (A. J. Kohn, Yale Peabody Mus.); Mulaka Atoll (Peggy Carpenter, ANSP). CEYLON: Trincomali (Brit. Mus.). ANDAMANS: Port Blair (Brit. Mus.). RYUKYUS: (ANSP; MCZ; USNM). FORMOSA: Taihoku-syn; Karenko; Garanbi; Hoko (all Kuroda, 1941, p. 104). PHILIPPINES: 6 fms., east end of Corregidor Id.; and near Cubat, Sorsogon Prov. (both Luzon Id., duPont-Academy Exped., 1958). Also records from Mindoro, Balabac, Cuyo, Bohol, Camiguin, Cebu, Catanduanes, Samar, Jolo, Sanga Sanga Ids. (all ANSP); Lubang, Mindanao and Negros

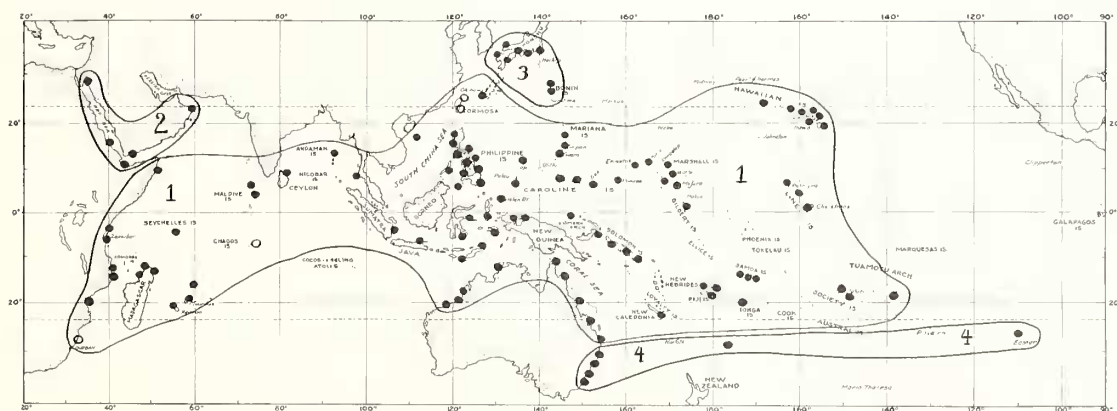


Plate 185. Geographical distribution of *Casmaria ponderosa* (Gmelin) and its subspecies. 1, typical *ponderosa* (Gmelin); 2, subspecies *unicolor* (Dautzenberg); 3, subspecies *nip-*

ponensis Abbott; 4, subspecies *pernyi* (Iredale). A fifth subspecies, *atlantica* Clench, from the Caribbean is not shown on this map.

Ids. (MCZ); Masbate Id.; Davao, Mindanao (both USNM). INDONESIA: Tengah Id., off Boeroe Id. and Mandidi Id., Moluccas; N. Loloda Id., west of Halmahera Id., and Batjan Id., Moluccas (all D. Fairchild, MCZ); Banda Id. (Natuurhist. Mus. Enschede); Poeloe Sebangka, Lingga Arch.; Wetar Id., north of Timor; Amboina; Timor (all Rijksmus. Leiden). NEW GUINEA: Rouw Id., Aori Ids., Geelvink Bay (A. J. Ostheimer, 3rd, ANSP); Djamma Id., (MCZ). CHINA: Paracel Ids. (Berlin Mus.). AUSTRALIA: WESTERN AUSTRALIA: Trevenard Id., and Long Id., and 8 fms. off Port Walcott (all M. E. King, BPBM). NORTHERN TERRITORY: 20 fms., 100 mi. N.W. of Darwin (Vernon Wells, ANSP). QUEENSLAND: St. Crispens Reef (T. Nielsen, ANSP); near Thursday Id. (V. Wells, ANSP); Heron Id. (ANSP); off Moreton Bay; Frazer Id.; off Caloundra; off Southport; off Tin Can Bay, Wide Bay (all Joy Kerslake, ANSP); Lizard Id., 150 mi. north of Port Douglas (Tony Marsh, ANSP). NEW SOUTH WALES: Trial Bay; Shelly Beach, near Yamiba (both J. Kerslake, ANSP). SOLOMONS: Roviana Lagoon, South New Georgia Id. (MCZ); Ususue, Malaïta Id. (J. van der Riet, ANSP); Buin, Bougainville Id. (A. H. Joyce, ANSP), NEW CALEDONIA: 10 fms., sand, off Noumea: 1 fm., 4 mi. W. by N. of Gatope Id., Voh (both G. and M. Kline, ANSP); Koumac (Maurice Frouin, ANSP). MARIANAS: Piti; Apra Harbor, Guam (A. J. Ostheimer, 3rd, ANSP and USNM); Agat, Guam Id. (USNM). PALAU IDS.: reef west of Malakal Harbor, Koror Id. (A. J.

Ostheimer, 3rd, ANSP); 2-5 fms., 1 mi. east of Round Rock, Helen Reef (V. Orr, ANSP). CAROLINES: Yap Id.; Faraulep Atoll; Lukunor Atoll (all USNM); Ponape (W. H. Pease, MCZ); Nukunoro Atoll (V. Wertley, ANSP); Mortlock Id.; Kapingamarangi (BPBM). MARSHALS: Bikini, Rongelap, Majuro, Eniwetok, Kwajalein, Taka, Ujae, Lae, Ailuk, Ujelang and Wotho Atolls (all USNM). FIJI: Akuilan Id.; Namotu Id.; 5-20 fms. off Namotu Id., N.W. Viti Levu Id. (all A. Jennings, ANSP); Suva (H. S. Ladd, USNM). GILBERTS: Apaiang Id. (A. Garrett, MCZ). HAWAIIAN CHAIN: 64 and 66 fms., off south end Molokai Id. ("Albatross" Sta. 3845, USNM); off Waikiki, Oahu Id., 35-50 fms. (D. Thaanum, USNM); off Launiupoko, Main Id., 4-12 fms. (D. Thaanum, USNM); Anau Channel, 2128 fms. ("Albatross" Sta. 3871, USNM); 15 fms., in sand, Keehe, Oahu Id. (C. S. Weaver, ANSP); Lisianski Id.; Hawaii Id.; Haena, Kanai Id. (all BPBM). LINE IDS.: Fanning; Christmas (both BPBM). SAMOA: Fagaitua Bay, Tutuila Id. (R. T. Abbott, MCZ); Ofu Id. (Ted Dranga, MCZ). TONGA: Nukualofa (BPBM). SOCIETY IDS.: Atiue, Tahiti (R. Robertson, ANSP); Borabora Id. (D. C. Voy, ANSP). TUAMOTUS: Raroia (Dautzenberg coll'n., Bruxelles).

Fossil Records—Pleistocene; 550 ft. alt., Kauain Stream, Lanai Id. (Harold Stearns, USNM). Pleistocene [?]: Rynkyu Limestone, Kikau-Zima (Nomura and Zinbo, 1934, 139) which I have not seen.

***Casmaria ponderosa subspecies unicolor* (Dautzenberg, 1926)**

(Pl. 14, fig. 5; pl. 186)

Range—Red Sea and the Gulf of Aden to the Gulf of Oman, Arabia.

Remarks—Most specimens from the above range characteristically have a very bulbous, swollen last whorl. This swelling is high on the whorl, so that the shell has a somewhat roundly tabulate appearance. Fresh specimens may have a peculiar greenish lead background with a coarse cobwebbing of bluish brown, or they may be cream-white or yellowish brown. In some specimens the subsutural and basal row of spots may be weak, small or nearly absent, a fact which led Dautzenberg to propose the name *unicolor*. The characters of this subspecies have not become uniformly established in this area. Specimens may be extremely small (23 mm.) or very large (65 mm.) and, in some, the globosity may be as little developed as in typical southwest Pacific specimens.

Measurements (mm.)—

length	width	no. whorls	
72.0	48.1	8	largest; Red Sea
65.5	46.0	8	large; Eilat, Red Sea
58.0	35.0	7+	Jobal Straits, Red Sea
57.6	38.5	6+	Muscat, Oman
42.0	25.2	7	Djibouti, French Somalia
22.5	16.5	7	smallest; Eilat, Red Sea

Types—The type locality is "Red Sea". I was unable to locate the holotype either in Paris or in the Dautzenberg collection in Bruxelles.

Synonymy—

- 1827 *Cassis vibex* L., Audouin, Descr. Egypte, vol. 22, Expl. planches Savigny, p. 186.
 1869 *Cassis quadrata* Link, Issel, Malocologia del Mar Rosso, Pisa, pt. 2, p. 121 (Mar Rosso); pt. 4, p. 349.
 1926 *Cassis (Casmaria) turgida* Reeve, var. *unicolor* Dautzenberg, Mémoires Inst. d'Egypte, vol. 11, p. 88, pl. 10 (6), figs. 6 (Red Sea).
 1935 *Phalium turgidum* (Reeve) var. *unicolor* Dautz., Bayer, Zoolog. Mededeelingen, Leiden, vol. 18, p. 114.

Records—RED SEA: Eilat, Gulf of Aqaba (H. Hadar, ANSP); Geb Zet (Lepsius, Berlin Mus.); Jobal Straits (Sozon Vatakotis, ANSP). FRENCH SOMALIA: Plage d'Arta, 50 kms. west of Djibouti (N. Lavergne, ANSP). ADEN: (Brit. Mus.). ARABIA: Muscat, Oman (D. T. Bosch, ANSP).



Plate 186. *Casmaria ponderosa* subspecies *unicolor* (Dautzenberg, 1926). Top two shells: 30 and 22.5 mm. in length, from Eilat, Gulf of Aqaba. Bottom shell: 51.3 mm. in length, from 50 kms. west of Djibouti, French Somalia.

Casmaria ponderosa subspecies nipponensis new subspecies Abbott

(Pl. 14, figs. 13, 14)

Range—Known only from Japan and the Bonin Islands.

Remarks—This is a very distinctive northern subspecies of Japanese cool waters which is characterized by its dull, brownish tan color, by its tan nuclear whorls and by the presence of 4 to 7 small prickles on the outer lip. These are located on the lower middle section and not at the base of the outer lip. The upper fifth of the last varix is without a brown spot. Below the suture are blurred darker-brown blotches, a feature present in the similar *C. ponderosa perryi* (Iredale) from southeast Australia, the Kermadecs, and Easter Island, and in the Polynesian *C. erinaceus kalosmodix* (Melville). This new subspecies has been identified in the past by Japanese workers as *cernica* Sowerby, which, however, is a dwarf, light-colored form of *ponderosa* from Mauritius. *C. ponderosa perryi* (Iredale) lacks the prickles on the outer lip and has white nuclear whorls. One specimen of *nipponensis* (USNM 205464) from 103 fathoms in the Kagoshima Gulf, Japan, is a grayish tan uniform color.

A brightly-colored specimen of *nipponensis* was purchased in Okinawa by Mrs. A. Anita Scott, but I have seen no other specimens from the Ryukyu Islands.

Description—Shell 33 to 53 mm. (about 1-1/4 to 2-1/4 inches) in length, ovate to elongate-ovate, dull to somewhat shining, moderately heavy, and colored in dark tan, cream and darker-brown blotches. Nuclear whorls 4, smooth and light-tan. Postnuclear whorls smooth, except for occasional microscopic growth lines, and moderately rounded. Suture smooth, minutely indented. Color of whorls in apex tan or with a purplish tan background, and with irregular blotches of light-chestnut brown just below the suture. Body whorl with these subsutural blotches and with 4 or 5 weak, spiral bands of indistinct tan, squarish blotches. Varix at outer lip moderately to heavily developed and bearing 5 to 10 brown streaks. Outer lip with 4 to 7 tiny, sharp denticles, but none at the base. Umbilicus minutely impressed. Parietal shield absent. Columella tan-cream and with 4 to 7 weak plicae, the lowest, however, being very strong and at the base of the columella. Interior of aperture cream to

light-brown. Edge of siphonal fasciole stained light-brown. A former varix may be present one half whorl behind the last varix. Spire variable in height, from 1/3 to 3/5 the entire length of the shell. Operculum and soft parts unknown.

Measurements—

length	width	spire	no. whorls	
58.0	33.0	22.5	7.5	Figured holotype, ANSP
53.1	27.2	20.5	6+	Kii, Japan, ANSP 241636
42.7	24.1	14.5	7.0	Tanabe, Japan, MCZ 233233
39.9	22.8	12.4	7.0	Sagami, Japan, ANSP 227579
33.4	20.5	9.8	6+	Sagami, Japan, ANSP 227579

Types and Records—The type locality is Tanabe, Wakayama Prefecture, south central coast

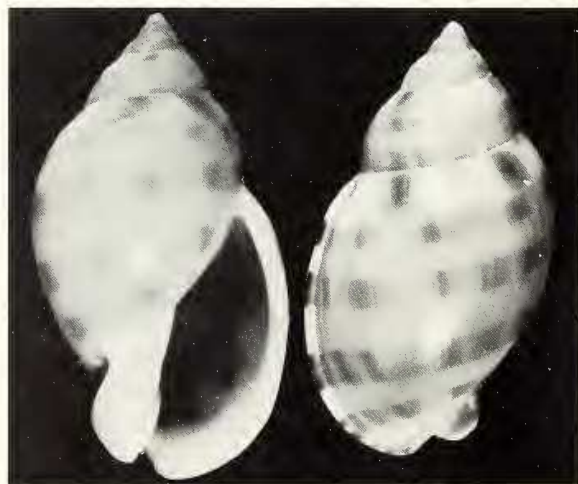


Plate 187. *Casmaria ponderosa* subspecies *perryi* (Iredale, 1912). Off Oruawharu, Great Barrier Island, North Island, New Zealand. 30.7 mm. in length. (photographs courtesy of A. W. B. Powell).

***Casmaria ponderosa subspecies
perryi* (Iredale, 1912)**

(Pl. 187)

Range—Southeast Australia, New Zealand, Kermadec Islands and Easter Island.

Remarks and Description—This subspecies is the southern counterpart to the northern subspecies *nipponensis* Abbott from Japan. Both have a dull taffy-brown or tan cast, with moderately strong and elongate brown blotches just below the suture and with 3 or 4 wide, light-brown, indistinct, spiral bands on the body whorl which bear irregular squarish, brown blotches. Characteristic of the *ponderosa* group is the unspotted, upper (or posterior) end of the varix. *C. ponderosa perryi* Iredale differs from *nipponensis* in having no denticles along the lower third of the outer lip, in having a weak varix, and in having cream-colored instead of dark-tan to light pinkish tan nuclear whorls. Both subspecies exhibit variations in the relative height of the spire, some being quite drawn out. The Australian subspecies was described from the Kermadec Islands, northeast of New Zealand, by Iredale who mentions that some few specimens may have a former varix on the last half of the body whorl, a feature seen in some Japanese specimens. I find no significant differences in the slightly plicated to smooth columellae of these two subspecies. The distribution of a cool water species or subspecies from New South Wales, to the Kermadecs and Easter Island is normal for some other groups of mollusks.

of Honshu Island, Japan. The holotype is in the Academy of Natural Sciences of Philadelphia, no. 313258. Paratypes are as follows: KYUSHU ID.: Kagoshima (A. R. Cahn, coll'n., ANSP 241668). HONSHU ID.: Kii, Wakayama Pref. (A. R. Cahn, ANSP 241646; 241636); Awa, Chiba Pref. (A. R. Cahn, ANSP 241141); Chiba Pref. (A. R. Cahn, ANSP 254723); Sagami Bay (B. R. Bales coll'n., ANSP 227579; Nat. Sci. Mus. Tokyo); Tanabe, Wakayama Pref. (MCZ 233233); 103 fms., Albatross Station 4935, Kagoshima Gulf (USNM 205464).

Measurements (mm.)—

length	width	no. whorls	
52.5	27.0	9	Queensland, Australia
43	24	—	type, fide Iredale, 1912
41.7	24.5	7+	Queensland, Australia
30.7	17.0	—	Gt. Barrier Id., N.Z., fide Powell, 1967

Synonymy—

- 1911 *Cassidea cernica* Sowerby, Iredale, Proc. Mal. Soc. London, vol. 9, p. 73 (Kermadecs).
 1912 *Cassidea perryi* Iredale, Proc. Mal. Soc. London, vol. 10, p. 227, pl. 9, fig. 17 (Sunday Is., Kermadec Islands).
 1967 *Casmaria perryi* (Iredale), Powell, Records Auck. Inst. Mus., vol. 6, no. 3, p. 186, pl. 36.

Types—The type locality is Sunday Island, Kermadec Islands, northeast of New Zealand. The holotype was deposited by Iredale in the Canterbury Museum, New Zealand.

Records—AUSTRALIA: Tuncurry Beach, New South Wales (Thornley, 1954, Proc. Royal Zool. Soc. N.S.W., for 1952-53, p. 33); 40 fms., off Caloundra, southern Queensland (T. A. Garrard, coll'n.); Point Cartwright, Queensland (Nat. Mus. Vict. F23207). NEW ZEALAND: on rocks just below low tide, Oruawharu, Great Barrier Island, North Island (Mrs. G. Mitchener, leg. 1965). KERMADEC IDS.: Sunday Island (Iredale, 1912, p. 227). EASTER ISLAND: (USNM).

***Casmaria ponderosa subspecies
atlantica* Clench, 1944**

(Pl. 14, figs. 15, 16)

Range—Lower Florida Keys, the Bahamas and Caribbean.

Remarks—This rare Caribbean subspecies is scarcely differentiated from certain specimens of *C. ponderosa* form *cernica* Sowerby, 1888, from the Indian Ocean. The shell of *atlantica* is slightly lighter in weight and the spots are more numerous in the four spiral series on the middle of the body whorl. I have never seen noduled specimens. This subspecies was treated in full by Clench in 1944 when he described it as a species and likened it to *Casmaria vibex* Linné (= *erinaceus* Linné, smooth form), rather than to the *ponderosa* group.

Young smooth forms of *Phalinn granulatatum* resemble this species, but *atlantica* is narrower, has a minute brown line on the suture of the first whorl, lacks reticulated sculpturing on the early whorls and has 5 to 9 minute prickles on the lower half of the outer lip.

Synonymy—

- 1935 *Phalium erinaceum* var. *vibex* Linné, Bayer, Zoologische Mededeel., vol. 18, p. 112.
 1944 *Casmaria atlantica* Clench, Johnsonia, vol. 1, no. 16, p. 3 (Puerto Sosua, Hispaniola).

Records—FLORIDA: 190 feet depth, off Destin, Florida (Frank Warder, coll'n.); 4-5 miles N.N.E. of The Elbow, Key Largo, in 50-83 fathoms (L. A. Burry, MCZ). BAHAMAS: Bimini (Corinne Edwards, 1967); Abrahams Bay, Mariguana Id.; Matthewtown, Great Inagua Id. (both MCZ); New Providence Id. (ANSP). CUBA: outer beaches, Guantanamo Naval Base (Kathy Carson and Pauli La Plante, 1967, ANSP). HISPANIOLA: Monte Cristi; Puerto Sosua (type locality) (both MCZ). VENEZUELA: near Caracas (Ch. Bayer, 1935, p. 112).